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Domestic Implementation of a Chemical Weapons Treaty

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To determine the effects on and the role of industry in the event of implementation of a chemical weapons treaty, this report analyzes the way in which the proposed treaty can mesh with the U.S. regulatory system, examines whether and how existing reporting and inspection requirements or regulations can be used to facilitate domestic implementation, studies the domestic implementation procedures and experience gained from the U.S.-International Atomic Energy Agency Safeguards Agreement, and develops some general observations and recommendations pertaining to legislative and regulatory approaches to U.S. treaty implementation. The authors describe the background of the present chemical arms control system and summarize the U.S. Draft Convention; list the specific chemicals that are included in either the U.S. Draft or the Rolling text and indicate the chemical-specific provisions; review the major regulations that are relevant to treaty chemicals and consider how databases associated with these regulations can be used for treaty compliance; identify producers of certain treaty chemicals and present case studies on two such chemicals; review and analyze the most pertinent arms control precedent for the type of domestic implementation scheme envisioned under the Chemical Weapons Convention.

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Domestic Implementation of a Chemical Weapons Treaty

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PREFACE

This report describes the findings of a study of issues bearing on U.S. domestic implementation of a comprehensive chemical weapons arms control treaty now being drafted at the United Nations Conference on Disarmament. It should be of interest to defense and arms control planners, analysts, and negotiators, as well as industry representatives, government regulators, and others who are likely to be affected by national and international programs for implementing the treaty.

The study was sponsored by the Office of the Under Secretary of Defense for Acquisition; it was carried out in the Applied Science and Technology Program of the National Defense Research Institute, RAND's OSD-supported federally funded research and development center.

The report reflects events that occurred before August 1, 1989.

SUMMARY

Not since the First World War has the world been so aware of the existence of chemical weapons. The targeting of civilians and military personnel in the Persian Gulf and the proliferation of chemical weapons capability to over 20 nations, some of whom are simultaneously acquiring missile and other systems that could deliver chemical agents against cities, air bases, and other area targets have alerted national and international leaders to the breakdown of restraints against chemical weapons use. Both superpowers and a number of other nations have encouraged, for reasons that are humanitarian but have important national security and political dimensions, the strengthening of the present system of chemical weapons arms control that is based on the Geneva Protocol and the reluctance of nations to initiate gas warfare. For over a decade, the United States has been engaged in complex multilateral UN-sponsored negotiations and bilateral negotiations with the Soviet Union to draft a comprehensive arms control treaty that would prohibit the production, stockpiling, transferring, and use of chemical weapons. The treaty, when completed, is expected to go beyond the Geneva Protocol and the Biological Weapons Convention by including a system of monitoring to effectively verify compliance. The system, as currently defined, is to be implemented by an international agency and includes a series of declarations, reporting requirements, on-site monitoring by instruments, and on-site inspections. Virtually all parties involved in the negotiations believe that on-site procedures are necessary to compensate for the inability of surveillance by national technical means (NTM) to provide sufficient verification capability. Both the January 1989 Paris Conference and the international debate surrounding the Libyan chemical facility at Rabta underscore the importance of rigorous on-site inspection in verifying that chemical weapons have been produced or used. Although satellite imagery and intelligence data provided early information on Rabta, there was considerable interest in establishing "ground truth."

Privately owned commercial facilities as well as defense installations will be affected by the treaty because of the desire to verify the nonproduction of chemical weapons and the nondiversion of key chemical precursors that are but one or two reaction steps removed from possible chemical weapons (CW) production. A domestic implementation system will be necessary to assure that the United States is in compliance with the treaty and to facilitate the verification of U.S. compliance by the international treaty agency.

The RAND study reported here has used both the 1984 U.S. Draft Convention, tabled at Geneva by Vice President Bush, and the "Rolling Text," a periodically published UN document summarizing the results of multilateral CW negotiations at the UN Conference on Disarmament, as primary sources for defining the objectives, roles, and activities likely to be involved in domestic implementation.

In the United States, chemical warfare agents themselves and the facilities that produce or store them are government owned and operated. These agents and facilities are certain to be regulated by the treaty. In addition, two or possibly three other classes of chemicals and their associated facilities are likely to fall under treaty jurisdiction. In the United States and other market economies, these latter facilities are owned and operated primarily by private industry.

The first type is a facility producing key precursors that have some civilian applications, but can be converted to chemical weapons in one or two additional reaction steps. There are roughly between 10 and 30 of these sites in the United States (perhaps 100 worldwide) producing some millions of pounds annually of these chemicals.[1] The facilities would be declared, be subject to stringent reporting requirements, and be subject to routine (systematic) on-site inspection by an international team.

The second type is a facility producing widely used high-volume toxic chemicals such as phosgene or hydrogen cyanide. In the United States, production is in the billion pounds range. Facilities producing such chemicals would not be declared or subject to routine inspection, and only aggregate national data would be required. Although these chemicals are no longer taken seriously as weapons by the major powers, they could be used in regional or domestic conflicts against unprotected civilians and troops. In addition, the extraordinary ubiquity and high volume of these chemicals combined with a typical material balance accuracy of 5 to 10 percent imply that millions of pounds worldwide could potentially be diverted to CW use without being detected by material accounting.

The third type of facility, whose inclusion in the treaty is still controversial, produces highly toxic chemicals that are not designated as chemical warfare agents. Proponents of inclusion claim that declaring and inspecting these facilities could reveal the parameters of the civilian industrial base that could potentially be converted to produce toxic chemical weapons. Several proposals for registering these facilities as well as those that *could* produce key precursors and exposing them to ad hoc inspections are also under discussion.

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[1]These numerical estimates are highly imprecise. It would be useful, in terms of understanding the full impact of the treaty, to possess accurate data regarding production volume, facilities, exports, and international trade. Such data are not now available.

It is generally agreed that surveillance by NTM alone will be inadequate for treaty monitoring of technologically advanced countries and that verification, to be effective, will require a combination of NTM, monitoring, and routine on-site inspection (OSI) of declared facilities, and short-notice or challenge inspection of undeclared but suspect sites. Since suspect facilities will not be restricted to declared sites, virtually all production plants as well as other suspicious sites could be subject to short-notice challenge OSI. Although the full impact of the reaction to the Libyan CW plant has not yet been felt at Geneva, several major issues have surfaced that could materially influence the treaty's verification scheme. Despite a lack of empirical data, there is now general agreement that a single OSI of a suspect plant cannot adequately determine whether CW or its precursors have been produced recently or whether they are likely to be produced in the near future. Even a single rigorous short-notice inspection, involving legitimate delays of up to 48 hours, is not likely to detect recent CW production in a multi-purpose complex.

Furthermore, the media-reported U.S. reluctance to reveal certain information regarding sensitive intelligence and satellite sources suggests that even if a comprehensive ban were to be implemented, the United States and other nations could require considerable time to convince allies and others that a potential circumvention of the treaty has occurred.

Related to the issue of effective verification is the need to define militarily significant quantities for chemicals whose diversion to military purposes could be important. Militarily significant quantities are highly scenario dependent and are influenced by a number of factors that are not well characterized. For example, quantities that could alter the pace or course of a European war could be in the range of 10^4 tons, quantities to seriously degrade a number of vulnerable key facilities in Europe might be an order of magnitude less, and quantities that could be valuable if used by less developed adversaries in regional conflicts or even against indigenous populations could be in a much lower range. Presumably, treaty proposals will reflect these various scenarios as the focus of interest shifts from East-West issues to nonproliferation and preventing the production, possession, or use of CW by less developed countries. The shifting focus could also alter the final configuration of the treaty toward emphasis on controlling diversion, exports, and the international distribution network that supplied Libya, Iran, and Iraq with CW know-how, technology, and materials. The activities of the Australia Group, a loose affiliation of industrialised Western nations plus Japan, are intended as a first multilateral step in controlling proliferation by harmonising export controls on

chemicals that could facilitate CW production. Thus a number of additional changes in the treaty can be anticipated before it is in final form, with corresponding modifications in the requirements for domestic implementation. To avoid instant obsolescence under these circumstances, the study team has attempted to strike a balance between findings that are generic and those that are more detailed.

Our principal observations, conclusions, and recommendations include the following:

- The Chemical Weapons Convention (CWC) differs from other arms control agreements because of the central role of private industry in producing chemicals that have legitimate commercial use but could be diverted to CW production. Treaty negotiators from the Arms Control and Disarmament Agency (ACDA), Department of Defense, and the Department of State have been consulting with representatives of the chemical industry using the mechanism of a special panel of the Chemical Manufacturers Association (CMA), the dominant chemical industry organization representing nearly 200 chemical manufacturing firms which produce 90 percent of U.S. chemicals. As U.S. industry and the panel members have become sophisticated about the treaty and how it might effect their operations, they and their counterparts in Japan and Western Europe have begun to play a more active role in influencing policy. Although industry's role is unofficial and advisory, it is becoming a major participant in the negotiations. However, a number of smaller enterprises including producers, suppliers, processors, traders, brokers, and shippers who could be affected by the treaty have not yet been brought into U.S. treaty deliberations. An aggressive attempt should be made to involve these firms and to ensure awareness of the special problems they pose, perhaps through other more specialized trade associations, one of several federal agencies that already monitor or regulate chemical activities, or an announcement in the *Federal Register* soliciting comments and participation. In addition to the absence of smaller firms, top management of the larger chemical companies may not be completely aware of the various ramifications of the CWC and its potential impact on all their divisions and subsidiaries despite the active role played by CMA and the concurrence of its leadership. If history is a guide, the support of high-level industry executives will be required during ratification or other congressional hearings.
- The U.S. chemical industry generally supports the concept of a comprehensive chemical weapons treaty, in contrast to the 1925

opposition to the Geneva Protocol by a number of industry representatives and the American Chemical Society. Although chemical company representatives support the treaty, they question the effectiveness of a system that omits surveillance of traders, brokers, and shippers who may facilitate the international distribution of chemical weapons-related material. To remedy this omission, they are attempting to formulate an international reporting, monitoring, and inspection system for controlling exports and imports of pertinent chemicals and technology for possible inclusion in the CWC. Industry is becoming increasingly sensitive to the potentially intrusive nature of on-site treaty verification, and is starting to press for a verification system that could be less stringent than is included in the U.S. Draft or the Rolling Text, claiming that burdens and risks to industry should be commensurate with corresponding improvements in verifiability. Industry, however, may not be sufficiently aware of the government's interest in balancing equity, effectiveness, and efficiency and the possibility that procedures that appear onerous, unwieldy, and not very effective in the technologically sophisticated U.S. setting could be effective and perhaps even necessary to detect or deter noncompliance elsewhere. American industry is beginning to seek alternatives to routine OSI of facilities that produce key precursors. It claims that routine inspections are not likely to enhance the ability to detect cheating or deter diversion to illicit purposes, and that such inspections would have limited capacity to verify material accounting data reported by a signatory. Industry would prefer that key precursor facilities be inspected only as a result of short-notice challenge of sites that are suspected of noncompliance or diversion, presumably to be requested infrequently. The use of waste, effluent, and other forms of external monitoring as a possible substitute for routine OSI may also deserve consideration, with such monitoring to be coordinated with careful scrutiny of product and shipping materials. External inspections, although not able to confirm the accuracy of material accounting records, could help determine whether a facility is producing treaty-banned substances and could deter noncompliance by the routine surveillance of facilities that might be involved in violating the terms of the treaty. However, evaluating the effectiveness of external monitoring requires a substantial database, most of which is not now available.

- Industry is most concerned about the loss of intellectual property such as proprietary material, trade secrets, and confidential business data. Such loss would result primarily from on-site inspections but also from data reported for purposes of treaty compliance. We suggest that the International Atomic Energy Agency (IAEA) Safeguards program, although in general not a suitable model for CWC verification, possesses elements that could be adapted successfully to treaty monitoring since IAEA safeguards also involve reports, declarations, and international inspections of commercial facilities. Provisions which are included in the U.S.-IAEA agreement or the U.S. implementing regulations and which may be adaptable to chemicals include a right of refusal on inspectors, the participation of facility operators in planning inspections, protection against commercially sensitive material being taken off-site, nondiscrimination against individual facilities or facility operators in terms of eligibility for OSI, and quantitative goals for material accounting and verification. Unfortunately, some IAEA policies, particularly as they are translated into practice, may hamper the ability to detect or even deter diversion. Analogous policies for the CWC case could result in minimal intrusiveness, but could also limit the effectiveness of verification. Despite all precautions, there is no guarantee that commercial losses will not occur. The rather sketchy data available on IAEA performance suggest that a multilateral inspection team may be prone to intentional lapses in confidentiality but these lapses, paradoxically, can assist the verification process. They could also lead to the illicit transfer of technology and industrial espionage. The IAEA does not engage in policing or investigative activities, and prefers a conciliatory rather than adversarial approach in its operations. Furthermore, it is becoming increasingly bureaucratized and controlled by nations who wish to encourage technical assistance rather than nonproliferation activities. Only one-third of IAEA's resources are devoted to safeguards, the remainder going toward nuclear development, technical assistance, and safety. Although a chemical counterpart to IAEA could operate with a similar "carrot and a stick" approach to encouraging participation in arms control and CW nonproliferation, this might lead to a potentially schizophrenic situation where resources could be depleted by requests for technical chemical assistance from developing nations.
- From the legislative history of the U.S.-IAEA safeguards, we judge that Congress is likely to raise a number of questions

during the ratification hearings pertaining to the impact of the treaty's intrusiveness on the competitiveness of domestic industry, particularly the impact on smaller firms who may be affected by its implementation and who would find the additional burdens of reporting and inspections to be onerous. Some form of compensation or assistance for firms subject to OSI may be requested to facilitate both industry cooperation and congressional support. The appropriateness of such assistance needs to be carefully evaluated, given the tradition that the costs of complying with government regulation are generally considered to be part of the normal costs of doing business.

- Existing chemical reporting procedures mandated by environmental and other statutes cannot provide the specific data required for treaty compliance in an efficient and effective manner. A small new chemical treaty group, to be organized after enabling legislation is passed authorizing domestic implementation, will be more effective at gathering the required data and is also far more likely to gain the cooperation of the chemical industry than the use of existing regulatory institutions. The newly formed On-Site Inspection Agency (OSIA) seems well-suited to house this group, in that it already has the mission of coordinating Intermediate-range Nuclear Forces (INF) treaty inspection activities in the United States and has developed an infrastructure for implementing arms control agreements. A slight modification of OSIA's authorizing legislation might be necessary, but the new agency's unique experience in implementing INF inspections abroad and coordinating them at home makes it an ideal candidate to assume responsibility for the domestic implementation of the CWC and other anticipated arms control agreements.
- Although a number of important questions still remain to be answered, we foresee no fundamental barriers to the implementation of a domestic system in the United States for demonstrating compliance with the CWC on the part of U.S. industry, provided that treaty supporters are sensitive to the need to obtain timely and appropriate legislative authorization. Even the issue of "anywhere, anytime" challenge inspection of relevant private facilities can be satisfactorily resolved, we believe, by adopting an administrative procedure already used by the Occupational Safety and Health Administration: obtaining an ex parte warrant prior to inspection. This procedure should satisfy concerns about potential conflicts between arms control OSI and the Fourth Amendment and could serve as an interim

or even fallback position in the event of legislative or judicial rejection of warrantless OSI.

- Significant barriers to progress, if they exist, come from a widely held skepticism regarding the ability to verify adequately or, at the international level, from the complexity and detail that negotiators in Geneva are addressing with regard to verification, the volatile political context in which multilateral negotiations occur, East-West and North-South differences, and the increasing involvement of both the United States and world chemical industry as participants. This involvement, while desirable from the perspective of developing consensus for the treaty, could potentially hamper the development of effective verification proposals. The unwieldy multilateral problem could be partially ameliorated by subsidiary bilateral arrangements between the United States and the Soviet Union. Industry should also be challenged by treaty negotiators to prepare, in a highly confidential manner, a risk assessment for OSI of the specific facilities that are currently envisioned as being subject to routine inspections. This assessment, which can be performed accurately only by experienced chemical plant operators, should define the sensitivity to industrial espionage and illicit technology transfer in a far more precise fashion than is currently available. Only in this way can a realistic evaluation of industry's potential losses be made.

A national and international political consensus for a comprehensive chemical weapons treaty is now being formed as events continue to demonstrate the inadequacy of the present arms control regime. A comprehensive and effectively verifiable treaty that is supplemented by export controls and monitoring of the international distribution network for chemicals and chemical technology would be the most significant step toward rolling back the spread of chemical weapons. Ultimately it could even lead to a world without chemical weapons. However, the detailed policies, architecture, and feasibility of such a system still remain to be developed, particularly as the fallout from the Libyan plant and the 1989 Paris Conference is beginning to settle. Treaty verification is likely to be viewed with greater realism by participants at Geneva, and there is now considerable uncertainty over the scope and detail of the domestic implementation provisions. Despite this uncertainty, we judge that the task of developing a domestic implementation system that is effective, equitable, and efficient, is difficult, but feasible.

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Appendix

FIGURE

TABLES

I. INTRODUCTION

The use of chemical weapons in the war in the Persian Gulf, Iraq's use of poison gas against its Kurdish minority, the acquisition of chemical weapons capability by 20 nations including considerable stocks held by the major powers, and the desire by perhaps 10 other nations to join the chemical weapons "club" underscore the fragile status of international barriers against the use and spread of chemical weapons (CW) and the need for a comprehensive and effectively verifiable chemical weapons treaty. Other recent instances of alleged CW use and production, the growing recognition of poison gas as the "poor man's atomic bomb," the proliferation of chemical weapons technology by importation or indigenous manufacturing, and the simultaneous spread of CW-capable delivery systems including missiles that could deliver CW against civilians in cities and large area military targets suggest that the present system of chemical arms control is in danger. This system relies on the Geneva Protocol, a general consensus among nations against use, and deterrence. Tens of millions of persons are already at risk of chemical attack and hundreds of millions could soon find themselves at risk as the range and accuracy of ballistic missiles continue to improve. The acquisition of CW capability by states such as Libya, Syria, and Iran with a tradition of state-supported terrorism is another ominous sign. Furthermore, the utility of a policy of deterring an adversary's first use by maintaining an ability to retaliate in kind may be limited in regions where the concepts of martyrdom and holy war influence military decisionmaking.

For a number of years before the recent emergence of chemical weapons as a serious threat to regional stability, the United States, as part of a group of 40 nations, has been engaged in negotiations to draft a comprehensive Chemical Weapons Convention (CWC) at the UN Conference on Disarmament (CD) in Geneva. In addition, the United States and the Soviet Union have been involved in a series of related bilateral negotiations. The proposed comprehensive CWC, when completed, is intended to prohibit (a) the development, production, acquisition, stockpiling, retention, or transfer of chemical weapons, (b) preparing for use of chemical weapons, (c) assisting or encouraging anyone to engage in such activities, and (d) use of chemical weapons in armed conflict.

The treaty, if and when it enters into force, may go far beyond the present system of chemical arms control that seems to rely as much on

the effectiveness of chemical or other forms of deterrence as it does on the obligations imposed by the 1925 Geneva Protocol, in which nations declared, often with reservations, that they would not use poison gas in time of war. It has generally been agreed that the Geneva Protocol is no longer adequate since it lacks means to verify or enforce compliance and depends for its implementation on the traditional diplomatic and political ways in which violations of accepted international conduct are treated. It is also agreed that the Geneva Protocol should be supplemented or replaced by a more comprehensive and stringent approach that includes provisions for verifying compliance.

NEED FOR ON-SITE VERIFICATION

Such a comprehensive approach is reflected in the U.S. 1984 Draft Convention, CD/500, a document that remains the formal expression of U.S. policy. Its goal is to establish a regime for chemical arms control that includes a rigorous system for performing the arms control verification functions of detecting noncompliance, deterring cheating, and building confidence. Virtually all major participants at the CD agree that on-site inspections (OSI) are needed for verification because national technical means (relying on remote imagery or sensing) cannot necessarily distinguish chemical munitions. Some chemicals with peaceful uses can also be used in chemical weapons production, and facilities for producing chemical weapons are not distinguishable from those producing ordinary industrial chemicals. Representatives of the Western chemical industry and other technical experts agree in principle with the need for a rigorous system, but are becoming increasingly insistent that the verification regime be realistic in terms of feasibility and efficiency. This agreement in principle contrasts with reports that U.S., West European, Indian, and Japanese firms assisted or attempted to assist Iraq, Libya, and Iran in acquiring CW capability.

As we shall later describe, industry is concerned about the possibility of intrusive data reporting, monitoring, and on-site inspection protocols that may place it at risk of losing proprietary data, thus damaging productivity and increasing costs. The chemical industry's role and burden will depend both on provisions in the final ratified document and the nature of the domestic system for implementing the treaty.

RELATION TO THE CHEMICAL INDUSTRY

The details of the proposed treaty and its protocols are still being drafted by an ad hoc group at the Conference on Disarmament, and a number of fundamental issues remain to be resolved. The pace of

progress has not been uniform, and negotiators often seem bogged down in endless technical detail. In addition, the truly multilateral nature of the negotiating process may hamper progress. Nevertheless, as shown by the Intermediate-range Nuclear Forces (INF) treaty process, negotiations can be driven by political will, although the verification aspects of the treaty are inherently far more complex than anything envisioned during the INF negotiations.

As distinct from the Geneva Protocol, the proposed treaty is not self-implementing. A series of international and domestic steps are required for its implementation, similar in spirit to the implementation of the Nuclear Nonproliferation Treaty through International Atomic Energy Agency (IAEA) and domestic safeguards. As the treaty appears to be evolving, both from the 1984 U.S. Draft and the documents known as "Rolling Texts,"[1] it seems clear that the chemical industries of the treaty signatories will be expected to cooperate in terms of declaring facilities and reporting certain information, and will be subject to various types of on-site inspection procedures to be carried out by international inspection teams. Involvement of the chemical industry is necessary because of concerns that even nonweapons chemicals pose risks due to the possibility of diversion from civilian production to military use (SIPRI, 1986). The concerns are expressed as a series of specific obligations on nations that can be carried out only with the cooperation (or coercion) of their chemical industries. For example, facilities that produce chemicals that are easily converted to chemical warfare agents would provide detailed data for ultimate transmittal to an international secretariat and are also subject to periodic on-site inspection, whereas facilities that produce other lethal or toxic chemicals and precursors that are widely used in commerce would be subject to declarations of production and end use. Some declarations pertain to production facilities that could be converted to the production of treaty-limited substances by virtue of their ability to manufacture or handle toxic material. In addition to routine inspections, even suspect facilities may be subject to challenge on-site inspection procedures. Adding to its impact on the Department of Defense, which controls all CW-related activities, the treaty would require mechanisms for civilian domestic implementation to assure that appropriate data are collected from industry and processed according to treaty protocols, that the chemical industry is informed of its rights and obligations with regard

[1]Rolling Texts are periodically published documents that record the results of scheduled multilateral CW negotiations held at the UN Conference on Disarmament. Formally, they are reports of the Ad Hoc Committee on Chemical Weapons to the Conference on Disarmament.

to monitoring and on-site inspections, and that confidential proprietary information is safeguarded.

OBJECTIVE OF STUDY

The objective of the study was to explore domestic implementation issues of the treaty, with particular emphasis on the role of the chemical industry. To accomplish this we (a) analyzed the way in which the proposed treaty can mesh with the U.S. regulatory system, (b) examined whether and how existing reporting and inspection requirements or regulations can be used to facilitate domestic implementation, (c) studied the domestic implementation procedures and experience gained from another international agreement, the precedent-setting U.S.-IAEA[2] Safeguards Agreement that established the first system of international on-site inspections in the United States for declared government and commercial nuclear facilities, and (d) developed some general observations and recommendations pertaining to legislative and regulatory approaches to U.S. treaty implementation.

The treaty is still under negotiation, and recent experience with the INF agreement suggests that policies and technical details may change abruptly in response to political realities. Furthermore, the world's chemical industry is becoming increasingly aware of the potential impact of the CWC and is now entering the negotiating process in a significant way. To a great extent, the chemical industry is becoming a key player in the negotiating process.

In the next section, we describe the background of the present system of chemical arms control, and to illustrate important treaty elements, summarize the U.S. Draft Convention. In Sec. III and App. A, we list the specific chemicals that are included in either the U.S. Draft or the Rolling Text and indicate the nature of the chemical-specific provisions. It is emphasized that the Rolling Text is a document that is constantly being updated, and attempts at detailed analysis are similar to tracking a moving target.

In Sec. IV, we review the major regulations that are relevant to treaty chemicals and consider in a generic way how databases associated with these regulations can be used for treaty compliance.

In Sec. V and Apps. B and C, we try to identify producers of certain treaty chemicals and show the results of case studies on two treaty

[2]The IAEA has been providing safeguards to ensure against diversion from civil nuclear facilities in countries without nuclear weapons ("nonnuclear weapons states") for 30 years. The application of IAEA safeguards to the United States, as a nuclear weapons state, was negotiated in 1977.

chemicals for which sufficient open data were available to make production estimates. We also describe procedures that might be involved in auditing to determine whether diversion has occurred.

In Sec. VI, we review and analyze the most pertinent arms control precedent for the type of domestic implementation scheme envisioned under the CWC. This is the IAEA Safeguards program under which international inspectors visit government and commercial facilities, and data are gathered and transmitted to an international agency. The U.S. implementation of the U.S.-IAEA Safeguards Agreement offers a number of revealing lessons that may bear on CWC implementation. Although the IAEA Safeguards program is in general not an appropriate model for CWC verification, a number of specific lessons learned from IAEA operations could be useful in facilitating domestic and international implementation of a chemical treaty. Finally, in Sec. VII and App. D, we note some key observations and conclusions, and make a number of preliminary recommendations that could facilitate domestic implementation, as well as provide a more effective system for chemical weapons arms control and disarmament.

The research described here, although reflecting significant events occurring through June 1989, was largely completed before the January 1989 Paris Conference, the disclosures about the role of German, Japanese, U.S., Indian, and West European firms in assisting Libya, Iran, and Iraq to acquire CW, and the heightening of policy interest in controlling the spread of CW. Although there is considerable momentum toward establishing a CW nonproliferation regime, it is too early to see how this will affect the CWC. We believe that Sec. VII is sufficiently robust to encompass considerable deviation from the presently anticipated configuration of the treaty as it would affect domestic implementation.

II. TREATY BACKGROUND

GENEVA PROTOCOL

The United States is a party to the 1925 Geneva Protocol prohibiting the use in war of asphyxiating, poisonous, or other gasses and of bacteriological methods of warfare. The protocol was signed in 1925, rejected by the Senate in 1926, resubmitted to the Senate in 1970, and ratified in 1975. A reservation was added by the United States affirming the right to retaliate with chemical agents if an enemy state or its allies violated the protocol. Because of the large number of signatories who affirmed the retaliatory right, the protocol is essentially a declaration of no-first-use. The treaty is self-implementing. There is no explicit mechanism or system for verifying or enforcing compliance, and there are no restrictions on the production, stockpiling, transferring, or development of chemical weapons. Furthermore, there is no system required for implementing the treaty by signatories. The 1989 Paris Conference reaffirmed the Geneva Protocol and brought the number of signatories to 123.

In contrast, the Biological Weapons Convention, also ratified in 1975, extended the 1925 no-first-use stricture for bacteriological weapons to a pledge never to develop, produce, or stockpile biological weapons or their means of delivery. The convention again does not include any system for verifying compliance, but instructs parties to the convention to lodge a complaint with the UN Security Council if it finds a breach on the part of other signatories.

A number of attempts to control chemical weapons preceded the 1925 Geneva Protocol. The 1899 Hague Convention (not signed by the United States) banned the use of projectiles whose sole purpose was to emit asphyxiatory or harmful gasses, and there is some evidence that this convention inhibited British, but not German, development of poison gas. The United States signed and ratified the 1907 Hague Convention which, by banning poison or poisoned weapons and material that caused unnecessary suffering, was interpreted by some as prohibiting the use of chemical weapons.

Following the First World War, the Treaty of Versailles banned the use, manufacture, and importation of toxic agents and material intended for their production by Germany. (No enforcement or verification system was included in the treaty although Germany was required to disclose production details for all explosives and toxic substances.)

In 1922, four years before the Senate's rejection of the Geneva Protocol, the Senate ratified a similar treaty that had been drafted by the Washington Arms Conference. The treaty never entered into force when France refused to sign because it included a ban on submarines.

The period between 1922 and 1926 saw a considerable increase in lobbying, some of it by U.S. industry, against a prohibition on the use of chemical weapons. The lobbying consummated in the Senate's failure to ratify the protocol in 1926. The treaty, with reservations, was ultimately ratified in 1975 at the same time as the ratification of the Biological Weapons Convention.

THE 1984 U.S. DRAFT

The Geneva Protocol is closer to biblical injunction than an arms control agreement. It is brief and contains little detail. As verification and implementation procedures are added, the required level of detail will increase considerably, particularly when the various appendices are included. We expect that the final CW treaty, protocol, and memorandum of understanding will encompass hundreds of pages and will require implementing U.S. legislation and regulations that could also be quite extensive. The U.S. Draft Convention was tabled at Geneva by then Vice President Bush, and is still the formal U.S. position. It was not written in formal treaty language, and was considered to be an organic document that could be modified through discussion and negotiation.

Before discussing domestic implementation, we review the major provisions of the U.S. Draft. Both the Draft and the Rolling Text are virtually silent about detailed methods for monitoring and controlling the international transfer of chemicals, technology, and know-how that could result in the further proliferation of CW capability.

Toxicity

Chemicals are distinguished from each other on the basis of their degree of toxicity, and are classified into super-toxic lethal, other lethal, and other harmful chemicals, based on a standard toxicological protocol. Super-toxic lethal chemicals correspond to those whose LD_{50} (the dose that kills 50 percent of test animals) is less than 0.5 mg/kg (mg of chemical per kg of body weight), other lethal chemicals correspond to those whose LD_{50} is less than 10 mg/kg, and other harmful chemicals correspond to those with LD_{50} greater than 10 mg/kg injected subcutaneous dose. Three schedules are listed, by way of

example, that correspond to different levels of both risk and monitoring. Schedule A includes super-toxic lethal chemicals, certain key precursors, and other particularly dangerous chemicals which are either usable as chemical weapons or which pose significant risks and have no current nonmilitary uses. Key precursors are chemicals which are but one or a few reaction steps removed from the ultimate chemical warfare agents. This schedule corresponds to Schedule 1 in the Rolling Text.

Schedule B includes chemicals that are widely produced for commercial use but have been used as weapons in the past and thus have a risk of diversion. Phosgene and hydrogen cyanide are two well-known examples. The schedule corresponds to Schedule III in the Rolling Text. It also includes chemicals that could serve as precursors for toxic agents. To illustrate the scale of production of Schedule III chemicals, we refer to App. C, where the U.S. demand for phosgene and hydrogen cyanide is estimated in the billions of pounds range. The worldwide economy of these commodity chemicals, some with a history of use as poison gas, is several billion pounds, and a typical material balance[1] uncertainty of 5 percent suggests that large quantities of the chemicals could be diverted to illicit use with small chance of discovery by material accounting.

Schedule C includes key precursors with nonmilitary utility whose production is permitted but is subject to systematic on-site verification. The schedule corresponds to Schedule II in the Rolling Text.

We note that toxic chemicals are defined by their level of toxicity in a standard toxicological test and not by their method of production. Thus Schedule A includes a marine toxin, saxitoxin, that might otherwise fall under the Biological Weapons Convention. Schedule A might also include ricin, a toxin that was used to assassinate the Bulgarian diplomat Markov but is also produced in small quantities for cancer treatment.

It has been proposed to include a separate category of super-toxic lethal chemicals that have non-CW applications (Schedule IV). The intention of the reporting requirements for these chemicals is to gather data on production capacity that can be converted to CW manufacture, and thus to monitor at least crudely a nation's ability to convert facilities to the production of super-toxic lethal material that could be weaponized. The fact that toxicity is not the sole discriminant for chemicals but is supplemented by their proven or potential utility as weapons makes the classification system somewhat less precise than it appears to be. Negotiators in Geneva do not yet agree on the

[1]Material balance is equivalent to conservation of mass.

definition of a chemical weapon, and the need for a separate Schedule IV is still under discussion. Further, the recent surfacing of an international trade in thiodiglycol, a Schedule B substance that can form mustard agent after reacting with hydrochloric acid, may encourage a review of the various schedules. It is interesting to contrast treaty chemicals with those that are included in the Australia Group core and warning lists. The Australia Group lists include chemicals such as thionyl chloride and sodium fluoride, which have many civilian applications, although they can also be used to produce CW. The philosophy behind the Australia Group lists is that nations with limited chemical processing infrastructures would need to import such common chemicals for purposes of CW production, even if they are not uniquely related to CW.

Weapons Stocks

Details of all chemical weapons stockpiles and recent transfers would be declared within 30 days after the Convention enters into force. The declarations are to be verified by on-site inspection and continuous instrument monitoring. All stocks are to be destroyed within ten years, and their destruction monitored by systematic OSI, continuous instrument monitoring, and the presence of international inspectors on a continuous basis. The U.S. Draft has no provisions for security stocks, builddowns or the retention of agents as deterrents against their use by nonsignatories. The French have proposed and apparently withdrawn a proposal for the maintenance of security stocks.

Chemical Weapons Production Facilities

All CW production facilities would be declared and would stop all activity except that required for closure. Declarations would be confirmed by OSI, and the facilities monitored by on-site instruments and periodic OSI until destruction. Destruction would occur within ten years, and the completion of the destruction process would be verified by OSI and monitoring.

Permitted Activities

Activities permitted to protect against a chemical weapons attack include the limited production of super-toxic lethal weapons and key precursors for protective purposes. Limited amounts can be made in a single small-scale facility that is subject to declarations, on-site

monitoring, and periodic OSI. No specific quantitative limit has yet been defined, although it is expected to be in the kilogram range.

Nonweapon Chemicals

Limited production and use of super lethal and key precursors would be permitted for research, medical, or protective purposes in approved facilities, although no quantitative limits have been agreed on. Schedule C chemicals would be subject to detailed reporting requirements and systematic (routine) OSI. Schedule B chemicals would be subject to annual aggregate reporting requirements. Later, we discuss the pros and cons of systematic (routine) OSI of facilities producing key precursors, a provision that has aroused the world's chemical industry.

Challenge or Short-Notice On-Site Inspections

The United States has proposed two categories of "challenge" OSI for situations in which there are suspicions of treaty noncompliance. We assume here that short-notice and challenge inspections are virtually identical, although the term "challenge" is far more provocative than "short-notice." These are inspections of declared or undeclared facilities and are in addition to designated periodic on-site inspections for purposes of verifying chemical weapons stockpiles and production facilities and their destruction, monitoring the single small-scale protective facility, and the routine systematic OSI of facilities producing Schedule C chemicals.

A special OSI, commonly known as an Article X OSI, is the most rigorous and potentially intrusive OSI. It permits a special "anywhere, anytime" OSI that may be initiated through any member of the Fact-Finding Panel of representatives from the United States, Soviet Union, the Alliance, Warsaw Pact, and the neutral or nonaligned nations. The panel acts as a filter for requests for challenge. Upon request for a fact-finding inquiry from any signatory regarding a special OSI, the panel will convene immediately. If any member of the panel agrees to the request, an inspection team consisting of regular treaty inspectors who are nationals of the fact-finding states is to have unimpeded access within 48 hours to (a) any facility listed in the treaty, (b) any military location or facility owned by the government of a party, or (c) any "relevant" location regardless of the economic or political systems of the party, including any private or government location that may be suspected of violating the treaty.

An ad hoc OSI, commonly known as an Article XI OSI, is somewhat less intrusive than the special OSI because it permits the challenged party to refuse entry for exceptional reasons and to offer alternative means of verifying questions about compliance. If the Fact-Finding Panel finds the alternative means inadequate, a second request may be granted. If access is again denied, the matter is submitted to the UN Security Council. The Fact-Finding Panel, after a request, meets within 24 hours, and decides on the question of sending an inspection team.

Governance

In addition to the measures outlined above, the Draft includes provisions for a consultative committee, an executive council, and a technical secretariat to carry out the work of the Treaty Organization. The consultative committee is to meet annually and is responsible for selecting the executive council and the Fact-Finding Panel. The executive council is responsible for the implementation of the treaty, including the various inspections, as well as the administration of the technical secretariat. The U.S. Draft also stipulates that the consultative committee should not decide whether any signatory is complying with the terms of the treaty, nor should it vote on reports of any fact-finding inquiry.

RETHINKING CHALLENGE OSI

As might be anticipated, the notion of challenge OSI has been subject to considerable discussion since 1984, both internationally and within the United States. Although it now appears that the concept of challenge OSI for undeclared but suspect sites is accepted by the superpowers, a number of objections have been raised, not against article X per se, but against similar provisions in the INF and START (Strategic Arms Reduction Talks) agreements. RAND is currently completing a study, under Joint Staff sponsorship, that specifically explores the risks and benefits of challenge OSI in the context of chemical weapons arms control. Although it is still too early to tell, it is possible that challenge OSI proposals will be further modified in the wake of the Paris Conference and the U.S. announcement of the Libyan chemical weapons facility.

Precedents from INF and START

Challenge inspection of suspect sites for purposes of verification has been considered for INF and START proposals as well as the CWC. Recent experience regarding challenge OSI in its pure "anytime, anywhere" form may suggest its ultimate role in the CWC but we believe that the differences between INF and chemical weapons verification could motivate retaining some form of OSI of undeclared facilities.

The risks and benefits of "anytime, anywhere" were recently subject to considerable debate, primarily during the INF treaty drafting process. According to reports, early U.S. INF drafts included a short-notice "anytime, anywhere" provision for inspecting declared or undeclared facilities that were suspected of treaty noncompliance (Gordon, 1988; Smith, 1987; Committee on Foreign Relations, 1988). The reports also suggest that the provision was opposed by intelligence and counterintelligence experts, nuclear weapons developers, and some military and defense officials who were concerned about potential risks to U.S. security from Soviet inspectors gaining access to sensitive U.S. intelligence, nuclear, and military installations, and military-related research, development, and production sites. The final draft of the INF treaty omitted any provision for challenge inspection of undeclared suspect facilities, presumably because the added verification benefits of challenge OSI (as a supplement to National Technical Means—NTM) were felt to be outweighed by the potential risks of losing sensitive material to the Soviets. An additional argument was invoked that verification with NTM alone became more feasible as the INF treaty evolved from numerical limits on short and medium range missiles to an outright ban on the existence and testing of such weapons. Ultimately, INF short-notice inspections were restricted to declared facilities.

A number of variants of "anytime, anywhere" challenge OSI were considered during the INF drafting process, primarily to minimize access to national security sites that were deemed too sensitive for inspection. Little attention was given by negotiators to the protection of commercially sensitive material. The possibility of exemption from OSI on the basis of supreme national interest was not considered for commercial facilities unrelated to national security, since such facilities would not be plausible sites for engaging in INF treaty limited activities. This contrasts with the chemical case and the ubiquity of commercial plants that could produce key precursors or other CWC associated materials.

One OSI variant, the "Fruit Loops/secret list" approach, was intended to limit inspections of suspect undeclared sites pertaining to

national security, but to permit OSI of commercial sites. Under this plan, a Soviet challenge OSI of a commercial facility (the factory producing Fruit Loops breakfast cereal was used as an illustration) would be permitted after first consulting with the facility's owner. However, if the Soviets asked to inspect a highly sensitive defense installation, the United States would retain the right of refusal. Both sides individually would maintain secret lists of installations that would not be open to inspection. This plan was withdrawn because of the difficulties and risks inherent in preparing such lists, the potential for misunderstanding when a request for challenge is denied, and the possibility of abuse.

Ultimately, the U.S. list of declared INF facilities that would be subject to OSI omitted any purely civilian sites, although contractor-operated U.S. launcher and missile plants were included. Inspections of these plants by Soviet inspectors and the various measures adopted by plant operators to prevent losses of proprietary material would provide useful insights about the conduct of OSI in a commercial facility, albeit one devoted to defense production.

The Debate Over Challenge OSI for START

Recent developments underscore the likelihood that the CWC's verification provisions will be influenced by START developments as well as INF. Current discussions of challenge OSI differ from those of the past, when it was generally assumed that inclusion of OSI in an arms control proposal would result in Soviet rejection. It is generally agreed that it would be more difficult to monitor START treaty compliance than INF, and that the CWC would be more difficult than START. Thus, some types of OSI might be viewed as beneficial for CWC, given the consensus that remotely monitoring chemicals by NTM seems difficult at best. As described above, it was only during the late stages of the INF treaty process that the net utility of unrestricted suspect OSI for INF verification was evaluated and the concept discarded because of potential risks to U.S. national security. The 1987 Washington Summit issued guidelines for START that included the short-notice OSI of declared sites and the right to implement short-notice inspections "at locations where either side considers covert deployment, production, storage, or repair of strategic offensive arms could be occurring." (Committee on Foreign Relations, 1988.)

More recently, Graybeal and his associates (Graybeal and Krepon, McFate and Graybeal, Graybeal and McFate) critiqued challenge OSI of undeclared sites for START. They concluded that for START limited items, NTM supplemented by routine inspection rights at the

most verifiable points in the production and deployment pipeline would provide a verification regime that would permit detection of militarily significant violations in time to respond effectively. They generally downgraded the substantive value of OSI, and recommended that short-notice challenge inspection be dropped from the START treaty to "avoid security problems, reduce opportunities for mischief-making, and produce a better START agreement."

Despite its concurrence with the consensus position that START verification is considerably more difficult than INF, the Senate Foreign Relations Committee recommended strongly against "anytime, anywhere" inspections for START after reviewing risks and benefits. The committee's views are expressed on p. 68 of the Committee Report on the INF Treaty (Committee on Foreign Relations, 1988).

> Absent a right of refusal, "anytime, anywhere" inspections have the potential for damaging U.S. security. Since it is highly unlikely that the Soviet Union would ever permit U.S. inspectors to discover Soviet violations of a START treaty, such inspections really have only one benefit: that is, deterring Soviet violations in the first place (although such inspections could also be employed to clarify misunderstandings). Weighed against the prospect of giving Soviet inspectors access to sensitive U.S. facilities, most committee members believe that on balance "anytime, anywhere" inspections in START have limited value and pose considerable risks.

Implications for the CWC

National security critics of "anytime, anywhere" OSI have not yet seriously addressed CWC verification. We suspect that arguments similar to those for INF and START will be made against permitting Soviet (and other nations') inspectors to visit sensitive facilities that are not identified in CWC declarations. It would not be surprising, therefore, if formal proposals that flow from the 1984 U.S. Draft and more recent government deliberations were to reflect a reluctance to permit foreign inspectors to visit sensitive national security facilities that have never been related to chemical weapons. This poses a difficult problem for treaty drafters who must formulate an OSI regime that can provide the benefits of effective worldwide CWC verification while narrowing the universe of non CW-related national defense establishments that may be challenged. If the resolution of the problem is to restrict OSI to facilities that are associated with the chemical weapons pipeline (weapons deployment, weapons storage and transfer, weaponization, agent production, agent storage), it seems likely that certain commercial chemical production facilities will still be subject to OSI, perhaps even of the "anytime, anywhere" type.

The Senate Foreign Relations Committee, in its endorsement of the INF treaty, described it as providing an "affective verification standard." It also recommended that the same standard should be met by the START verification regime: a regime that is able to detect militarily significant Soviet violations in time for the United States to respond effectively. For missiles, such a regime emphasizes missile deployment rather than production sites, and relies heavily on NTM for monitoring. Our discussions[2] with a number of experts reveal that the chemical weapons version of the "effective verification standard" remains to be formulated. The problem is to translate a statement of policy goals into practice. Further difficulties arise with the notion of military significance, since this concept becomes highly scenario dependent for chemical weapons. To illustrate, the military value of several hundred tons of chemical weapons may be far less significant in a NATO-Warsaw Pact tactical context than it might be in the Mid-East where it might be sufficient to alter the course of a regional conflict or could even be used to deter a nuclear attack. The concept of "political significance" is even more complex and scenario dependent than military significance.

Later we will discuss the evolving views of the chemical industry with regard to OSI. Although no consensus has yet emerged, industry now seems most concerned about the intrusiveness of routine inspections of key precursor production sites that are privately owned, and would prefer that an OSI of civilian facilities be of the short-notice or challenge type. This preference, we judge, is based on industry belief (or hope) that challenge inspections would be rare events, reserved for only the most serious of suspected violations. Under such rare circumstances, industry appears willing to tolerate intrusive inspections of both declared and undeclared facilities. It must be pointed out that reserving OSI for only the most serious cases could weaken its role in verification by increasing the diplomatic and political risks that need to be considered by decisionmakers. Thus, rarely invoked challenge OSI would have limited ability to build confidence among signatories, and might ultimately fall into disuse except as a political instrument. On the other hand, if challenge or short-notice OSI were to be invoked more frequently, say up to a maximum set by an agreed on quota, decisions about its use would be less highly charged and it could better promote confidence building. Presumably, the U.S./USSR experience over the next few years on short-notice inspections of INF sites will provide insights into the "routinization" of OSI.

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[2]The discussions were conducted as part of a RAND research study to explore the risks and benefits of challenge OSI for verification of the CWC.

Few empirical data exist to determine whether OSI of a chemical production plant can adequately verify compliance. Nevertheless, a new consensus has been forming in the aftermath of U.S. revelations concerning the Libyan CW plant. This consensus suggests that a single OSI, even one that is quite rigorous, may be unable to detect episodes of cheating in the recent past, and may only be decisive in the unlikely situation of a "smoking gun." Since any short-notice inspection could involve inevitable delays of 24 to 48 hours and perhaps longer from the time that incriminating data are first obtained until an OSI team can enter a suspicious facility, a technically adept plant operator could cover up signs of cheating, particularly in a multipurpose facility. While it would be difficult to determine whether a suspect site has in the past or is likely in the future to engage in illicit activities, we suggest that negotiators may wish to consider a new challenge protocol that includes the right to establish an on-site program of safeguards at a suspect facility. The program would include continuous monitoring and/or OSI until the facility is no longer designated as suspect. We have not explored the feasibility and procedures for such a program, deferring that to work currently being completed by RAND under Joint Staff sponsorship.

III. TREATY PROVISIONS AFFECTING THE CHEMICAL INDUSTRY

After a slow start, the U.S. and world chemical industries are playing an active role in influencing certain provisions of the proposed treaty, emerging as key advisors at the Conference on Disarmament. Since both the nation's and the industry's interests would be served by wider participation of those involved in chemical production, processing, and distribution to assure that the treaty is cost-effective and realistic, and that treaty supporters will not be surprised by strong protests from U.S. industry during ratification hearings, the time is ripe for even more detailed industry-government interaction. (See App. D for a discussion of the history of industry participation in regulatory rule setting.) The burden should now be on industry top executives and their technical staff to propose procedures that will balance effective verification against the risks of loss of confidentiality.

It is not sufficient that industry provide moral support for the treaty. The technical expertise to develop effective protocols resides mainly in industry, and the government needs to be able to screen industry's proposals for their effectiveness in verification.[1] The number and diversity of firms involved in treaty coordination must be increased if the treaty is to reflect the broad interests of industry, since a number of smaller firms including traders, brokers, processors, and shippers who are not actively involved in government industry dialogue may be affected by the outcome of negotiations. A definitive census of U.S. facilities and firms that would be affected by the CWC has not yet been made, despite attempts by the Chemical Manufacturers Association, the Arms Control and Disarmament Agency, and RAND. Preliminary estimates suggest that between 10 and 30 U.S. facilities qualify for routine OSI, but this number may change considerably as the scope and threshold of treaty provisions are further refined.

In the event that treaty negotiators adopt verification provisions like those described in Sec. II, the chemical industry will be strongly affected. In particular, American chemical manufacturers may be subject to new reporting and inspection procedures for certain esoteric chemicals, as well as for some that are widely used.

[1]An important point, obvious but not often stated, is that the U.S. government is interested in a treaty that balances equity, effectiveness, and efficiency. Thus, provisions that may appear onerous or even ineffective when implemented in the United States could have greater value elsewhere.

On the one hand, the chemical industry seems reconciled to supplying information to reassure concerned parties that chemical weapons are not being produced and that diversion is not occurring. On the other hand, certain procedures that could be required for proof of nonproduction or nondiversion may affect the proprietary rights of producers and consumers of affected chemicals.

In this section, we elaborate on the reporting and inspection provisions of the draft treaty and identify the chemical substances that are specified on the preliminary lists. We then list producers/suppliers of the phosphorus-containing chemicals, the most important substances for the manufacture of nerve agents. Finally, we comment on the difficulty of pinpointing producers and users of some substances that are listed generically in the treaty. Appendix A compares the corresponding schedule of the U.S. Draft and the Rolling Text, and Sec. VII includes more detailed comments about routine OSI.

DRAFT TREATY PROVISIONS

There are three sets of chemicals specified in the draft treaty and the Rolling Text. Another set, super-toxic lethal chemicals not associated with CW, is being discussed at Geneva. The U.S. Schedule A list contains "super-toxic lethal chemicals,[2] key precursors, and other particularly dangerous chemicals, which have been stockpiled as chemical weapons or which pose particular risk of such stockpiling" (CD/500, 1984). These correspond to Schedule I in the Rolling Text. Schedule B (Schedule III in the Rolling Text) contains chemicals produced in large quantities for permitted nonmilitary purposes but which "pose a particular risk of diversion to chemical weapons purposes." Schedule C (Schedule II in the Rolling Text) contains chemicals whose production for nonmilitary permitted purposes would be "subject to systematic international on-site verification, including key precursors." We discuss each of these groups of chemicals below in turn. Further detail is included in App. A, where a comparison is made with the Rolling Text. Schedule A does not include all super-toxic lethal chemicals but only those that seem especially relevant to CW. Other super-toxic lethal chemicals that have civilian applications and are not usually associated with CW are bracketed (subject to further discussion) in the Rolling Text to gather data on the location and capacity of production facilities that could be easily converted to CW manufacturing. These chemicals

[2]A super-toxic lethal chemical is defined as one with a median lethal dose less than or equal to 0.5 milligrams per kilogram by subcutaneous administration or 2,000 milligram-minute per cubic meter by inhalation.

have been the source of considerable debate, some believing that they could, if necessary, be included in the three main schedules, and others believing that a separate category may be necessary. If Ricin rather than Saxitoxin were included, the biotechnology and pharmaceutical industries would be directly affected since Ricin has medical applications. Since the treaty does not distinguish among the different means for producing chemicals, i.e., fermentation vs. chemical synthesis, the biotech industry could be involved if it produced any treaty-regulated substances.

Schedule A Chemicals

Table 1 lists the chemicals designated under Schedule A of the draft treaty. The first chemical is an organophosphorus nerve agent in the "V" family. The next three are nerve agents of the "G" family. The fifth chemical is mustard gas, a vesicant. The sixth entry, BZ, is a glycolate incapacitant. Saxitoxin, the seventh listing, is a shellfish toxin included to establish an overlap with the Biological Weapons (BW) Convention.[3]

Table 1

SCHEDULE A CHEMICALS

Chemical Name	Common Name
Ethyl S-2-diisopropylamino-ethyl methylphosphonothiolate[a]	VX
Ethyl N,N-dimethylphosphoramidocyanidate	Tabun, GA
Iso-propyl methylphosphonofluoridate	Sarin, GB
1,2,2-trimethylpropyl methylphosphonofluoridate	Soman GD
Bis (2-chloroethyl) sulfide	Mustard gas
3-quinuclidinyl benzilate	BZ
Saxitoxin	—
3,3-dimethylbutanol-2	Pinacolyl alcohol
Methylphosphonyldifluoride	—

[a]Listed incorrectly as ethyl S-2-diisopropylamino-ethyl methylphosphonothioate in CD/500 (1984).

[3]The Biological Weapons Convention has no formal mechanism for verifying compliance. The inclusion of a biological agent in Schedule A would establish a precedent for shifting jurisdiction over certain BW agents into an arms control regime that would have

Schedule B Chemicals

Schedule B chemicals are indicated in Table 2. All of these chemicals are commonly used in the private sector for various purposes; each would be subject to reporting requirements under verification. The phosphorus-based chemicals in the table—phosphorus oxychloride and phosphorus trichloride—are used widely as the source of many industrial chemicals. Hydrogen cyanide and phosgene are used in the production of plastics. The sulfur compounds are used in the vulcanization of rubber. Some Schedule B chemicals, although in the commodity chemical class, have a history of use in warfare. Although they are not taken seriously as military weapons by the major powers, they could be used against unprotected civilians and troops by less developed nations. The recent report that a U.S. firm, Alcolac, pleaded guilty to violating U.S. controls on the export of thiodiglycol underscores the role that even Schedule B chemicals could play in the Third World. The reaction between thiodiglycol and hydrochloric acid produces mustard gas, an agent that was used in the Gulf War (Warmkessel, 1989).

Table 2

SCHEDULE B CHEMICALS

Chemical Name	Common Name
Phosphorus oxychloride	—
Phosphorus trichloride	—
Carbonyl chloride	Phosgene
Cyanogen chloride	—
Hydrogen cyanide	—
Trichloronitromethane	Chloropicrin
—	—
—	—
—	—
Bis (2-hydroxyethyl) sulfide	Thiodiglycol

See Table 3.

more "teeth," and could also extend the treaty to biotechnology based facilities. The eighth and ninth chemicals are precursor chemicals for production of soman or GD and sarin or GB respectively

Schedule C Chemicals

The chemicals specified under Schedule C are key precursors used in industry that could be subject to systematic inspection on a routine basis. The list in Table 3 includes some chemicals used for nonmilitary industrial purposes. Some of the phosphorus containing chemicals are used as pesticide intermediates and quinuclidin-3-ol is used as a reagent.

IDENTIFYING PRODUCERS/CONSUMERS

Producers and users of the chemicals in Tables 2 and 3 are difficult to identify for a number of reasons. First, there is not a central directory of producers by chemical. Second, producers are reluctant to reveal the identity of their customers in verifying that certain chemicals or technology have not been diverted to CW production or

Table 3

SCHEDULE C CHEMICALS

Chemical Name	Common Name
Chemicals containing the P-methyl, P-ethyl, or P-propyl bond	—
Methyl and/or ethyl esters of phosphorus acid	—
3,3-dimethyl butan [illegible]-2	Pinacolyl alcohol
N,N disubstituted-[illegible]amino ethanols	—
N,N disubstituted-β-amino ethane thiols	—
N,N disubstituted-β-amino ethyl halides	—
Phenyl-, alkyl-, or cycloalkyl-substituted glycolic acids	—
3- or 4-hydroxypiperidine and their derivatives	—
—	—
—	—
—	—
—	—

exported abroad to countries seeking to acquire proscribed materials.[4] Third, many of the chemicals in Tables 1–3 are generic; identifying members of the classes is difficult. Fourth, phosphorus chemistry is complex and the common names used in the treaty lists do not immediately suggest a corresponding structure. Fifth, users, processors, and distributors may not know the precise chemical composition of the various compounds they obtain from manufacturers and use only the proprietary designation.

In spite of such problems, we have made an initial attempt (see App. B) to identify the producers and suppliers of the chemicals. Table B.3 lists the producers of the chemicals for which reporting is required and Tables B.1 and B.2 specify those chemicals subject to inspection.

Because of the third and fourth problems above—the generic listing and the common names—our tables are by no means exhaustive. No doubt more names would be forthcoming, and some could be deleted, if the federal government were to notify all manufacturers, processors, distributors, brokers, traders, and exporters to advise the government of activities and facilities that might be affected by the treaty. Furthermore, we have also used the CAS (Chemical Abstract Service) numbers in some cases to facilitate on-line searching of databases that pertain to environmental and toxic substance regulation. Many of these numbers can be found in CD/874 for chemicals listed in Schedules 1, 2, and 3.

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[4]In Sec. VII, we comment on the need for a more comprehensive regime that adds export controls and monitoring of the international chemical distribution network to deter diversion across borders.

IV. REVIEW OF REGULATIONS AFFECTING THE CW TREATY

The domestic chemicals industry is heavily regulated. The industry is systematically required to provide the government with information on the status of their operation, the conditions of their workplaces, and the health of their workers. Industry would prefer that the reporting and systematic inspection requirements of the treaty be satisfied by aggregation of the information obtained through the numerous regulatory statutes. In this section, we briefly review several of the most significant regulatory statutes affecting the chemical industry that pertain to the treaty requirements, and in Sec. V we specify the statutes that apply to each of the relevant treaty sections. In most cases, data of a sensitive or confidential nature (such as production levels, composition, customer names, etc.) can be treated as CBI (Confidential Business Information) and withheld from disclosure under the Freedom of Information Act. Chemical industry regulatory lore suggests that three years is the expected time for CBI data to "leak" from an agency.[1]

TOXIC SUBSTANCES CONTROL ACT (TSCA)

The Toxic Substances Control Act[2] was passed in 1976. It was designed to regulate the 65,000 existing chemicals in commerce and the 1000 or so new chemicals that enter the market each year. It was intended to prevent unreasonable risks of injury to health or the environment associated with the manufacture, processing, and distribution of chemicals in commerce. TSCA excludes certain classes of substances—nuclear materials are regulated under the Atomic Energy Act and pesticides are regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). A substance is considered a pesticide by the Environmental Protection Agency (EPA) when a firm submits an application for experimental use or registration under FIFRA. When the substance is still being evaluated in the research and development phase and has not yet been registered as a pesticide, it is regulated under TSCA. Intermediate and inert ingredients used or produced in the production or formulation processes of pesticides that are

[1]The export of chemicals that could be used to produce CW is regulated by the Bureau of Export Administration of the Commerce Department.

[2]15 USCAII §§ 2601-2629 (i.e., Title 15, U.S. Code Annotated, Sections 2601-2629).

not components of the products are also regulated under TSCA (Stever, 1985; O'Reilly et al., 1987).

It is worth noting here that the CW precursors, because they are not registered pesticides, would be regulated under TSCA. Chemical warfare agents themselves are exempt from TSCA, because of a national security waiver.[3] It is also possible that some of the other high-volume commodity chemicals listed in the treaty that could be diverted for CW production are registered pesticides.[4]

TSCA directed the EPA to compile and publish an inventory of existing chemical substances by November 1979. The initial list included over 44,000 substances that were manufactured as of 1979. The agency published a revised inventory in 1980. There are yearly updates as EPA has added new chemicals that enter commerce each year.

EPA passed a final rule in June 1986 for updating the inventory. It required manufacturers and importers of TSCA chemical substances to report current data on production volumes above 10,000 lb, and to specify all plant sites where the substance is manufactured. It indicated that such reporting should occur every four years thereafter (*Federal Register*, June 1986). Industry responses are being entered into the inventory. (An EPA official observes that a high fraction of respondents are now claiming confidentiality.)

It is important to note two facts about this inventory. Some treaty chemicals (like the agents themselves, for instance) will not appear in the inventory because TSCA includes a national security waiver or because they were not produced in 1977. Certain substances would be considered new rather than existing chemicals under TSCA. Other treaty chemicals (some of the high-volume commodity chemicals, for example) will appear in the inventory, but the information on producers and production will reflect the situation that existed in 1977. These substances would be regulated as existing chemicals under TSCA if they were not registered as pesticides.

The regulatory program of TSCA is established under Sections 4, 5, 6, and 7. Section 4 describes the testing of chemicals. Section 5 sets up procedures for screening new chemicals and new uses of existing chemicals. Section 6 details EPA's options for controlling manufacture, use, and disposal under the condition that data from sections 4 and 5 indicate a need for action. Section 7 allows EPA authority to deal with imminent hazards (Stever, 1986), and Section 8 details TSCA reporting requirements.

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[3] 15 USCA § 2621.

[4] We point out that hydrogen cyanide, as a fumigant, is regulated under FIFRA.

TSCA allows inspection of records, files, papers, processes, controls, and facilities where regulated chemical substances are manufactured, processed, stored, or held before or after their distribution in commerce.

FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA)

FIFRA[5] was originally passed in 1947 under jurisdiction of the U.S. Department of Agriculture. In 1972, Congress substantially amended the statute and transferred jurisdiction to the EPA. Another significant amendment took place in 1978.

FIFRA regulates pesticides which are defined as substances or mixtures of substances that are intended for preventing, destroying, repelling, or mitigating any pest or are intended for use as a plant regulator, defoliant, or desiccant.

A range of establishments must be registered under FIFRA. They include producers or establishments that manufacture, prepare, propagate, or process any pesticide or device or any active ingredient used in manufacturing a pesticide. Registration also includes various types of laboratories, distributors, retailers, commercial, and some private applicators and pesticide importers. Any registered establishment must report the types and amounts, and, if appropriate, active ingredients used in producing pesticides which it is currently producing, or which it produced, sold, or distributed in the previous year.

None of the CW agents and probably none of the key precursors identified in the treaty is now a registered pesticide. Some of the chemicals used in commerce that could be diverted for agent production are registered pesticides (see the hydrogen cyanide case study below). For these chemicals, the FIFRA database would list producers of chemicals used as pesticides and the amount they produce that is used in pesticide applications. It would not, however, contain total production levels if the chemical is used for other, nonpesticide purposes as well.

FIFRA allows inspection of books, records, and establishments.

OCCUPATIONAL SAFETY AND HEALTH ACT (OSH ACT)[6]

The purpose of the OSH Act of 1972 is to assure safe and healthful working conditions. The Occupational Safety and Health Administration

[5] 7 USCA §§ 121-136.
[6] 29 USCA §§ 651-678.

sets standards for workplace exposure to various substances, and requires that data sheets for toxic substances be available.

The OSHA inspection statute has established a legal procedure for unannounced inspections that would meet CWC verification requirements. This procedure could be the basis for U.S. domestic implementation of a "challenge" inspection. In 1978 the Supreme Court[7] held that an ex parte warrant can be obtained for an OSHA inspection if entry to an inspector is refused. The procedure does not require presence of the inspected party, nor showing of cause beyond reasonable administrative standards for conducting an inspection. Thus the advantages of surprise are not lost, and the warrant requirement imposes no serious burdens on the inspection system. An exception to the warrant requirement could be made if it were found that the chemical industry was "closely regulated" and that on-site verification represents an "urgent federal interest" justifying a warrantless inspection.[8]

For CWC purposes, legislation implementing the treaty must include an OSHA-like inspection provision authorizing the designated government agency to implement such inspections. The procedures established by the CWC to initiate inspections could be sufficient to meet domestic legal requirements. Access to private residences without probable cause requires a search warrant under the Fourth Amendment, but this is not a particularly significant restriction to the overall feasibility of short-notice challenge procedures. Further discussion of the legal dimensions of OSI are included in several recent articles (Tanzman, 1988; Connolly, 1987). Additionally, the presence of government representatives during inspections by the international team would serve to protect both U.S. interests and the interests of private facility operators.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

RCRA[9] was passed in 1976 as an amendment to the Solid Waste Disposal Act of 1965. The first phase of the regulations was not promulgated until 1980. It regulates hazardous waste management from the point of generation through ultimate disposal, creating a "cradle to grave" waste management system with monitoring, record

[7] *Marshall v. Barlow's, Inc.*, 436 U.S. 307(1978).

[8] See American Bar Association, Standing Committee on Law and National Security and Section of International Law and Practice, Report to the House of Delegates, July 1985.

[9] 42 USCA §§ 6901–6987.

keeping, and reporting requirements. It covers generators, transporters, and operators of treatment, storage, and disposal facilities.

The term hazardous applies to wastes that are specifically listed by EPA or to wastes that are ignitable, corrosive, reactive, chemically unstable, acutely toxic or those that exhibit toxicity according to a test called the Toxicity Characteristic Leaching Procedure (TCLP). A shipping manifest specifying the type and amount of waste must be prepared by all generators for waste leaving a site. Generators are responsible for keeping manifest records for three years.

Another reporting requirement under RCRA is the biennial report which must be filed by generators on even numbered years. These reports provide a complete picture of the generators' hazardous waste output for the year in question. Another provision requires a report of efforts to reduce waste volume and toxicity compared with the previous year's efforts.

Most of the treaty chemicals fall under the definition of "hazardous" under RCRA. The agents themselves, for instance, meet the criterion of acutely hazardous. EPA-listed wastes include treaty chemicals phosgene (P095), hydrogen cyanide (P063), and cyanogen chloride (P033). RCRA would primarily affect treaty chemicals if verification of nonproduction in commercial plants is to be facilitated by effluent and waste monitoring or by examining discharge data.

Any designated representative of EPA or the state may inspect information relating to wastes and any establishment or other place where hazardous wastes are or have been generated, stored, treated, disposed of, or transported from and they may obtain samples of wastes or containers or labeling for such wastes.

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (CERCLA)

CERCLA,[10] passed in 1980, established a so-called Superfund which would allow for cleanup of hazardous waste disposal sites and spills of hazardous substances. It covers the release or threatened release into the environment of any hazardous substance from a vessel, site, or facility. The statute only indirectly affects the treaty chemicals, many of which would be covered by the legislation.

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[10] 42 USCA §§ 9601-9657.

SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (SARA)

These amendments to CERCLA require owners or operators of facilities to complete a toxic chemical release form for each toxic chemical listed that was manufactured, processed, or otherwise used above a threshold quantity. This quantity is 10,000 lb for a chemical used at a facility. For a chemical manufactured or processed at a facility, it is 75,000 lb per year before July 1, 1988; 50,000 lb before July 1, 1989; and 25,000 lb after July 1, 1990.

The chemical release form will include the name and location of the facility, whether the chemical is manufactured, processed, or otherwise used and the general categories of use, an estimate of the maximum amount of the chemical present, the waste treatment or disposal method employed, and the quantity entering each environmental medium annually. The EPA is required to establish a national toxic chemical inventory. The SARA rules are in response to the Bhopal and Institute, West Virginia accidents. They also require that local safety officials be notified if certain substances of unusually high toxicity are present in a facility, to permit suitable responses in the event of accident or release. This information can be either aggregated or listed for each substance, depending on circumstances. The provision is essentially a "Community Right to Know Rule for Toxic Chemicals." A recent article describes the first few months experience with Community Right to Know (Kriz, 1988). The EPA administrator is also to have a mass balance study performed within the next five years, and no mass balance requirements are to be instituted until feasibility is established.

The SARA requirements would apply to some of the treaty chemicals on the basis of their toxicity. They are not on the current list, but it will almost certainly be expanded in the future. Although a number of the chemicals in Schedule C are highly toxic, their virtual absence from industrial use would account for their omission.

INTERNATIONAL TRADE COMMISSION (ITC)

The ITC, until 1974 known as the Tariff Commission, investigates the industrial effects of custom laws.[11] One of the provisions requires annual publication of its volume on Synthetic Organic Chemicals. Chemical producers are required to report on annual production and

[11] 19 USCA §§ 1330–1339.

sales levels. As described in App. B, the ITC volume identifies the producers of some of the treaty chemicals, but only if such identification is not considered to reveal trade secrets about market share.

V. MEETING THE TREATY REQUIREMENTS ON REPORTING

We have identified the regulatory statutes that could be used, in principle, to satisfy the treaty requirements for reporting and inspection. We also analyzed the treaty requirements generically in the context of these regulations. In what follows, we first review the current regulatory reporting regime. We discuss the protocol limitations of using existing statutes for the reporting requirements through case studies of two chemicals for which reporting would be required. Finally, we describe the barriers that arise if verification of nonproduction is required.

CURRENT REPORTING

The chemical industry is required to report detailed information on their operations and products to a variety of governmental agencies on a continuing basis. Some in industry and government believe that the data already reported under the statutes described in Sec. IV could be sufficient to satisfy the treaty requirements and that no new system for collecting data is necessary. Below, we consider two case studies of treaty chemicals in which we have attempted to satisfy the U.S. Draft and Rolling Text requirements using available information. Before we discuss the cases, we briefly review several relevant statutes and data sources in the context of a generic chemical in commerce.

When a chemical is first produced by a chemical company and the company believes the chemical to be marketable, permission for production can be granted under one of two statutes. Under TSCA, the producer first submits a Premanufacture Notice (PMN) containing information on the chemical. EPA examines the PMN and, in most cases, allows production, sometimes with certain controls. In the case of a chemical for use as a pesticide, the firm asks EPA for registration. Again, EPA can allow or disallow the registration.

In the early 1980s, EPA established an inventory under TSCA using 1977 information on existing chemicals in commerce. It specified the producers and the range of production. In some instances, producers claimed confidentiality; in those cases the firm and/or the production range is not listed. The inventory is being updated so that new producers since 1977 can be added. One EPA source indicated, however,

that a much higher percentage of producers are claiming confidentiality in the update.

Under FIFRA, chemicals used as pesticides are registered at EPA. Producers of active ingredients—those substances that are actually toxic to pests—are listed in the database, whereas producers of inactive ingredients are not. Processors (formulators) are also identified.

OSHA is designed to protect workers in the workplace and can inspect workplaces for adherence to health standards. It sets allowable exposure levels.

Many chemicals have a variety of uses. Some are used as pesticides and for other applications as well. The producers of such chemicals should, in principle, be listed under both TSCA and FIFRA. Other sources also list chemical producers. The ITC report, for instance, publishes annual production and sales and identifies the producers of certain synthetic organic chemicals. It gives production levels and specifies the producers of certain high-volume inorganic chemicals. The *Chemical Marketing Reporter* publishes chemical profiles of high-volume chemicals every three years, listing the producers, their capacity, and a rough breakdown of percentage end uses.

Import and export data on chemicals are collected by the Bureau of Census. Some chemicals are listed individually; others are listed in so-called "basket" categories, either because there is only one producer or because the trade value is below a threshold level.

An additional source of data is SARA, which requires the reporting of the presence (storage, production, processing) of certain chemicals. A proposed rule called CAIR, which has not yet gone into effect, would set up an inventory of producers, processors, and consumers of some of the chemicals regulated under TSCA, and could ultimately supersede all reporting requirements.

Waste generated in the course of producing, using, or processing chemicals is subject to RCRA, which sets up a tracking system for the waste from "cradle to grave." Firms generating, storing, transporting, or creating waste must fill out a manifest that specifies the amount and type of the waste.

Chemicals that have been disposed of on land or have entered water systems are subject to CERCLA, a statute that sets up the so-called Superfund for cleaning up various sites. Other statutes like the Clean Air Act and the Clean Water Act regulate atmospheric and water releases of chemicals during use, production, and disposal.

Reporting requirements of the chemical industry under all these statutes are extensive, and could be used, in theory, to verify and audit data submitted by individual facilities. Other sources of information on chemical production include the *Chemical Marketing Reporter*, a

trade publication, and various chemical buyer's guides. As mentioned earlier, the industry would like to use the existing data to satisfy the reporting requirements under the treaty. In the following case studies of two treaty chemicals we examine the adequacy of existing data.

CASE STUDIES

The two case studies we consider below are phosgene and hydrogen cyanide. These two chemicals (with a history of use as poison gas) are widely used in industry and we chose them largely because there is likely to be more data available on them than on the other treaty chemicals. Thus, if it were not possible to use existing data and publicly available sources to satisfy the treaty requirements for these chemicals, it would probably not be possible to do it for any of the chemicals on the list.

The treaty reporting requirements on the two candidate chemicals—Schedule B chemicals—are summarized in Table A.4 in App. A. For reference here, we repeat them. Under the U.S. Draft, annual reporting is required on

- The location of each production facility
- Aggregate quantities produced
- Aggregate quantities exported
- Aggregate quantities imported
- End uses

Under the Rolling Text—the working document for the negotiators—the requirements are more detailed. They include annual reporting on

- Production
- Consumption
- Imports
- Exports

and for final product or end use for each facility that produces, processes, or transfers chemicals

- Name and owner of facility
- Location of facility
- Capacity of facility
- Approximate amount of production or consumption

Phosgene

Phosgene is a high-volume commodity chemical used primarily as an intermediate in the production of other chemicals. Like other chemicals in Schedule B (Schedule III of the Rolling Text) it has either a history of or potential for use as an agent of warfare. Its major end uses are in the manufacture of toluene di-isocyanate (TDI) and methylene bisphenyl isocyanate (MDI), which are then used in foams, coatings, and polymers. There may be as many as 11 producers with a total annual plant capacity of about 2 billion pounds.

Draft Treaty Reporting. Appendix B lists the producers of the treaty chemicals from a variety of sources. Table B.3, in particular, lists the phosgene producers. Table C.2 in App. C lists the phosgene producers contained within the TSCA inventory.

The various sources identifying phosgene producers do not agree especially well. The International Trade Commission (ITC), for instance, identifies many fewer producers than does the *Chemical Market Reporter* (CMR). The TSCA list is undoubtedly out of date—1977 information was used to compile the inventory. The buyer's guides list additional producers—some probably small custom houses—that probably do not produce the chemicals but could if a buyer requested the substance. The disagreement among the sources indicates that even the identity of phosgene producers cannot be determined using published data.

The location of production plants—one of the draft treaty annual reporting requirements—is given only in the CMR and the TSCA inventory (see Tables C.1 and C.2 of App. C). The TSCA inventory list is out of date, and there is no way to verify the CMR data.

The ITC reports annual aggregate production levels for some chemicals. The TSCA inventory lists a production range for each plant; these ranges are so broad, however, that aggregation would lead to a virtually meaningless result (see Table C.2). The CMR reports a demand level for high-volume commodity chemicals every three years.

The ITC reports a production level for phosgene of 514 million lb in 1985. The CMR reports a demand level of 1586 billion lb in 1984, three times that of the ITC level. One explanation for the discrepancy may be that the ITC defines production to include only chemicals that are isolated in the process. Because so much phosgene is used as an intermediate, much of it may not be isolated.

The TSCA production ranges in the 1977 inventory are outdated. When the inventory is updated in the near future, the situation may not improve because many more producers are claiming confidentiality. Even ranges will not be listed in many cases. The net effect of the

limitations of the data sources is that the aggregate production level of phosgene cannot be determined from the available data.

We contacted the Bureau of Census to obtain 1985 and 1986 import and export data for phosgene. The chemical is reportedly in an undetermined "basket" category—a category for chemicals with one producer or a threshold production level. This seems curious since phosgene is a high-volume commodity chemical produced by a number of firms. The Bureau of Census indicated that a preliminary study could reveal which basket category phosgene was in and an expensive follow-on study would provide levels of imports and exports.

The only source of end uses of certain commodity chemicals is the CMR, a nonofficial but widely used publication. It gives a rough percentage breakdown of applications every three years in published chemical profiles. The breakdown for phosgene is shown in Table C.3. Although it is published only every three years, this information may be sufficient to satisfy the draft treaty reporting requirements.

Rolling Text Reporting. The reporting requirements are far more stringent under the Rolling Text. In addition to annual production, exports, and imports, it requires consumption levels. The definition of consumption in the Rolling Text is not clear. It may be simply production minus exports plus imports or it may account for some chemicals placed in inventory. In either case, we know of no published data on consumption.

The Rolling Text also requires a great deal of data for each end use from producers, processors, or transporters, including information on the name, location, capacity, and approximate amount of production or consumption. The CMR lists the two largest uses of phosgene as production of TDI and MDI. The CMR, in chemical profiles on phosgene, TDI, and MDI, publishes the producer, location, and capacity of each facility at three-year intervals. The ITC publishes annual production figures for certain isolated chemicals.

Other uses of phosgene in the CMR profile include "polycarbonate resins," and "other isocyanates, specialties, agricultural and miscellaneous uses." Obviously, information on such generically defined categories is not easily available.

Other requirements under the Rolling Text are the location of each plant producing, processing, or transferring an indicated chemical. If we can believe the CMR profiles as to producer identity, then the publication also shows plant location and capacity. Capacity, however, can mean a variety of different things and it is well-known that for short periods, plants can produce at 200 percent of design capacity, factors that treaty negotiators need to keep in mind. The CMR profiles do not include all the end uses, and plants where the phosgene is

processed or transferred are not identified. Furthermore, the CMR profiles are published only every three years.

Hydrogen Cyanide (HCN)

The second case study concerns HCN, like phosgene a commodity chemical used in the production of other chemicals. Its largest uses are for the manufacture of adiponitrile and the resin methyl methacrylate. There are currently eight producers holding 14 plants.

Draft Treaty Reporting. Table B.3 lists the producers of HCN as reported in a variety of sources. Note that the ITC volume on synthetic organic chemicals does not include HCN. Once again, even the identity of the HCN producers is in question because of the disagreement among sources. Tables C.5 and C.6 of App. C show the producers of HCN as listed in the CMR profile and the TSCA inventory, respectively. Again, the TSCA inventory list is based on old data and is not likely to be accurate.

An interesting feature of HCN is that it is produced as a primary product by some producers and as a byproduct in the production of acrylonitrile by other producers. The crude hydrocyanic acid produced in the process can be purified and sold or incinerated (EPA, 1986). Primary producers of HCN are not the only producers who will need to report under the treaty; byproduct producers will have to report as well.

We have not been able to identify any publicly available sources giving production levels of HCN. The 1984 CMR profile estimates demand for that year at 976 million pounds. The TSCA ranges for the 1977 production levels are of little practical use

The Bureau of Census data on HCN are similar to those of phosgene. The chemical falls into a basket category called "Inorganic Acids, Not Elsewhere Specified." An expensive effort would be required to obtain separate HCN values for exports and imports.

The CMR is again the only source of information on end use. But as we see in Table C.7 where the end uses are specified, some of the entries—chelating agents, for instance—are vague and generic. This may suffice, however, under the draft treaty requirements.

The Rolling Text. Beyond the requirements in the U.S. draft treaty, the Rolling Text specifies the location, capacity, and amount for each final product or end use for each facility that produces, processes, or transfers the indicated chemical. Again, through the CMR, we can identify producers of HCN, their locations and their capacities as given in Table C.5. For the end uses, however, this is more difficult. As discussed in App. C, the CMR lists three producers of methyl

methacrylate, one of the major end uses of HCN. Data for other end uses are largely unavailable.

VERIFICATION OF NONPRODUCTION

The treaty does not explicitly require verification of nonproduction for the chemicals in Schedules B and C, but it is rather the intent of the treaty to verify that such chemicals are not diverted to chemical weapons use. In what follows, we show that the level of data required to verify nondiversion through the reporting procedure is not now available and is not possible to obtain.

Figure V.1 shows a schematic representation of the pertinent elements for nonproduction or nondiversion verification. A materials balance—an accounting procedure of the chemical from production through to final disposition—is the only way to be sure that diversion to CW production is not occurring, and the present state of the art of materials balance may include uncertainties up to 5 or 10 percent. For large-volume chemicals, these uncertainties could be in the range of military significance.

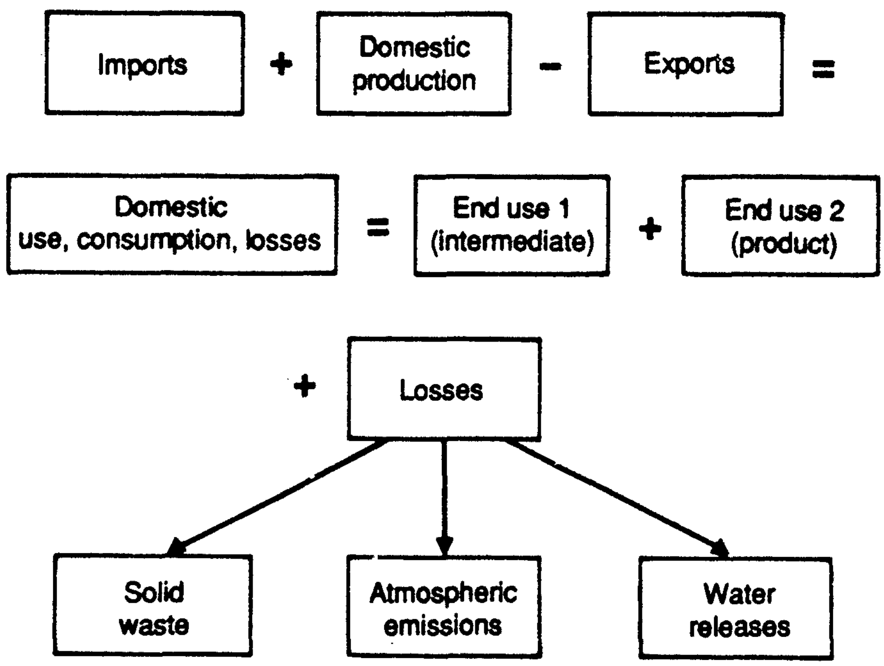

Fig. V.1—Elements of materials balance for verification of nonproduction

In Fig. V.1, for any treaty chemical, we begin with imports, add domestic production, subtract exports and are left with domestic use or consumption. There may be a number of end uses for a particular chemical, but for convenience here we show only two. The first use is an intermediate where the chemical in question is used captively to produce another chemical. The second use is for a product—perhaps a pesticide. During the production process of the chemical itself and the production process of the second chemical, losses occur to the atmosphere, to the water, and as solid waste. Such losses also occur as the chemical is used in the product. To obtain a full materials balance, the amounts of the chemical produced, used, or lost at each point must be accounted for.

In the previous subsection, we described the difficulties of obtaining information on production, use, imports, and exports using existing sources. Even if producers or trade organizations cooperate, there are severe problems in specifying the data sufficiently to perform a rigorous materials balance. Small amounts of a CW agent can be produced with small amounts of precursor and the accounting would have to be refined enough to suggest such diversion without a comprehensive system of physical inspections and monitoring.

A case in point arises in the chemicals industry for carbon tetrachloride, a high-volume commodity chemical. More than 90 percent of the chemical is used in the production of chlorofluorocarbons (CFCs). Of the 646 million lb produced in 1985, roughly 580 million lb went into CFC manufacture. The CFC manufacturers report that 2.7 percent of the carbon tetrachloride used in CFC production cannot be accounted for. If this is accurate, it implies that 15.7 million lb of carbon tetrachloride could be lost in the production process. If this chemical is typical of even a few of the treaty chemicals, then a large amount—of the order of millions of pounds—could be diverted for CW agent production without being detected by accounting procedures. Even a rigorous materials balance might be unable to account for large amounts of a chemical such as phosgene. In the United States, it is expected that as new plants go on-line they will have emissions approximating zero and more precise materials balance procedures. For such plants, effluent monitoring will be of limited effectiveness, but materials accounting could become more accurate. The possibility of such virtually zero-emission facilities being built outside of the West or Japan is not known but seems unlikely.

Another element in Fig. V.1 illustrates the complexity of materials balance techniques. The amount and type of solid waste generated during chemical production and use must be reported under the RCRA manifest system. In a chemical plant, the "front end" is a reactor in

which the chemical reactions take place, sometimes with a catalyst and elevated temperatures or pressures. At the "back end" of the plant, unreacted inputs are recycled back to the reactor and the reaction products enter a column for separation and purification. A still bottom probably considered a hazardous waste is generated in the distillation/separation process. It contains small amounts of the product being produced, small amounts of byproducts, trace amounts of the catalyst, unreacted inputs, and soils and oils.

If the production firm does not have an on-site incinerator, the still bottoms will have to be sent off-site for incineration or disposal. The amount or volume of the still bottom must be specified on the manifest. This waste, however, includes a significant number of substances that are not the chemical in question. The amount specified on the manifest exceeds the amount of the chemical of interest and the manifest data therefore are not useful for performing a rigorous materials balance without additional physical sampling.

Another example arises when a chemical is blended with other substances—in pesticide formulations, for instance. When the pesticide is applied, we can track the waste from the mixing process, but it will again exceed, perhaps significantly, the amount of the chemical of interest that is present. Evaporation of the pesticide might occur but, in general, we have little idea of the chemical characteristics of the mixture. Some of the pesticide may enter the water but, again, we have no valid method for tracking it.

Since materials balance and accounting procedures are potentially significant in evaluating compliance with environmental requirements, Congress mandated a five-year study of the feasibility of using materials balances in environmental regulation as part of the SARA statute.

In summary then, precise verification of nonproduction or nondiversion to agent use, especially for high-volume commodity chemicals, seems difficult, if feasible at all, without a program of rigorous investigation, monitoring, and inspection. One factor is that production cannot be measured within the tolerances required. Another factor is that a materials balance rigorous enough for precise estimation is not possible with existing data and may not be technologically possible even under a specially designed reporting regime. In addition, even well-controlled and monitored U.S. plants today may find mass balance discrepancies of between 5 and 10 percent, although these levels could improve in the future as new technology for complying with environmental rules is introduced. Thus, it appears that an intrusive system of inspection, investigation, and monitoring may need to be considered if there is a mismatch between militarily significant quantities and our ability to audit the diversion of such quantities. This is further discussed in Sec. VII.

VI. LEARNING FROM IAEA SAFEGUARDS

COMPARING NUCLEAR NONPROLIFERATION AND CHEMICAL WEAPONS ARMS CONTROL

On-site inspections are already part of four arms control or nonproliferation agreements (Military Liaison Mission in Germany, the Stockholm Convention, INF, and IAEA Safeguards program) to which the United States is a party. The only system that is multilateral and that approaches the scope and complexity of the regime envisioned in the proposed Chemical Weapons Treaty (CWC) is the program of international safeguards defined by the Nuclear Non-Proliferation Treaty (NPT) and agreements between the International Atomic Energy Agency (IAEA) and individual nations.[1] These agreements express the differing obligations of nuclear weapons states and nonweapons states with regard to nuclear safeguards. Some similarities between NPT and CWC are the infrastructure and procedures necessary to implement the treaty, including data gathering from government and commercial facilities for submittal to an international treaty agency, and the opening of domestic facilities to international officials for on-site inspection. A fundamental difference between the two treaties is that IAEA safeguards apply only to declared facilities that are intended for peaceful use, whereas CWC procedures are intended to apply to all facilities, both military and civilian, that are engaged in activities covered by the treaty.

Differences in technology, history, and objectives further weaken the CWC/NPT analogy, particularly since the proposed CWC goes far beyond nonproliferation and is also intended to impose identical controls on all signatories regardless of their status as a chemical weapons state. However, the unique experience gained during the nearly three decades of international nuclear safeguards and eight years of U.S. IAEA inspections can provide important lessons (and warnings) for the proposed CWC.[2] We will concentrate on the domestic implementation

[1]As bilateral negotiations continue between the United States and the Soviet Union, it is possible that subsidiary agreements between the superpowers may be implemented that would complement the multilateral arrangements described in the U.S. Draft and the Rolling Text. Other RAND research, soon to be completed, deals with the role of OSI under such circumstances. The present document considers primarily the multilateral arrangements.

[2]The pertinence of IAEA safeguards to chemical treaty verification is also discussed in a recent monograph, *International Atomic Energy Safeguards: Observations on the Lessons for Verifying a Chemical Weapons Convention*, by J. F. Keeley of the University

aspects, but will include several observations (that may also bear on CWC implementation) covering the evolution of the Safeguards program. We do not intend to evaluate the effectiveness of NPT/IAEA safeguards in preventing nuclear proliferation by deterring the diversion to military use of civilian material and facilities.[3] Such an evaluation requires data that we do not possess and cannot obtain without difficulty, is highly technology-specific, and would probably not apply to the CWC. We note that at least five nations have detonated nuclear explosives (United States, USSR, UK, France, and China) but 20 nations are reported to possess chemical weapons, including a number of nations with quite limited technological infrastructures. This confirms the relative ease by which CW capability may be acquired, compared to nuclear weapons. The IAEA claims that no anomaly that might suggest diversion to nonpeaceful use has yet been found, thus implying the success of its activities. Students of the IAEA are mixed in their rating of safeguards, but, on balance, most believe that even though the IAEA safeguards do not provide a policing function they have positively influenced nonproliferation.

THE NONPROLIFERATION TREATY AND THE IAEA

Following the end of the Second World War, the United States possessed a virtual monopoly on nuclear technology, materials, and weapons. At that time, U.S. nuclear export policy, expressed in the 1946 MacMahon Act, was to deny access to others by banning all nuclear exports. Following successful nuclear explosions by the Soviets and British, the U.S. policy of denying other nations any access to nuclear technology was changed to one of constructive engagement, as reflected in the Atoms for Peace Plan proposed by President Eisenhower in 1953. The plan was intended to promote the peaceful worldwide application of nuclear energy. It stipulated that states receiving U.S. nuclear assistance or exports guarantee nondiversion of nuclear material to weapons production. Recipients were also required to accept appropriate safeguards to demonstrate that diversion did not

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of Calgary, was prepared for the Arms Control and Disarmament Division, Department of External Affairs, Ottawa, Ontario, Canada, and is designated as Arms Control Verification Occasional Paper No. 1.

[3]Recent works dealing with the effectiveness and future of the nuclear nonproliferation and safeguards programs include *Nuclear Arms Control*, National Academy of Sciences, National Academy Press, Washington, D.C.; *Limiting Nuclear Proliferation*, edited by J. C. Snyder and S. F. Wells, Jr., Ballinger Publishing Co., Cambridge, Massachusetts, 1985; and a series of reports prepared by International Energy Associates under Arms Control and Disarmament Agency (ACDA) sponsorship.

occur. The MacMahon Act was amended in 1954 and the resulting Atomic Energy Act mirrored the new U.S. policy of nuclear cooperation—the trading of access to U.S. peaceful nuclear assistance in return for assurances of nondiversion and adherence to bilateral safeguards against diversion. The bilateral safeguards were to be superseded in time by an international system administered by the International Atomic Energy Agency, an organization first proposed as part of the original Atoms for Peace concept. Former Nuclear Regulatory Commission (NRC) Commissioner Victor Gilinsky, a prominent critic of IAEA, recently observed that the original 1953 proposal rejected worldwide inspection and control, but U.S. policy soon shifted toward encouraging the newly envisioned IAEA to administer and inspect bilateral agreements between its members. This policy shift occurred, Gilinsky suggests, to render safeguards palatable to states seeking to acquire nuclear technology (Gilinsky, 1985).

The role of safeguards was extended by the Non-Proliferation Treaty of 1968. Signatories of states without nuclear weapons agreed to accept IAEA safeguards on all peaceful nuclear activities rather than as a quid pro quo for nuclear assistance. In contrast, states with nuclear weapons were not required to accept safeguards. The nuclear weapons signatories were prohibited from transferring nuclear explosives to nonweapons states and from assisting nonnuclear weapons states in manufacturing, acquiring, or controlling nuclear explosives. Only later did the nuclear weapons states agree to accept certain limited forms of safeguards as a largely symbolic gesture.

The IAEA was founded in 1957 as an affiliate of the United Nations. Headquartered in Vienna, its two main functions are to promote peaceful uses of atomic energy through technical assistance and the setting of safety standards, and to apply international safeguards to deter the diversion of nuclear material from peaceful to military use. It is the first and only multilateral system in which sovereign nations permit international teams to collect data and to inspect both government complexes and private installations to verify an arms control agreement. Thus its successes and failures in practice deserve attention. However, for reasons that will become apparent, it does not offer a template for the CWC.

As noted earlier, only civil nuclear activities fall under the safeguards. CW treaty provisions, by contrast, include on-site inspections of declared military and contractor-owned facilities in the United States, but are purely bilateral in nature.

The verification of IAEA safeguards involves three phases whose cumulative intent is to establish the truth of statements made by nations and facility operators and as reported by them to the IAEA.

The phases include examining data provided by a state, collecting information from inspections to verify information on nuclear facility design, materials, records, and reports, and evaluating all data to assess the completeness, accuracy, and validity of state-provided information. It is important to note that IAEA does not attempt to play a policing role.

SAFEGUARDS VS. TECHNICAL AID

The IAEA's multiple objectives may sometimes conflict with each other (Scheinman, 1985; Scheinman, 1987; Fischer and Szasz, 1985). Safeguard activities consume about 35 percent of the total IAEA budget, and are estimated at about $50 million per year, whereas the major portion of IAEA resources are devoted to activities that promote nuclear technology through technical assistance. The IAEA has both the "carrot and the stick" approach to nations seeking nuclear technology: if nations wish assistance from IAEA, they must adhere to IAEA safeguards. About 98 percent of nuclear plants outside the five declared nuclear weapons states (United States, USSR, UK, France, and China) are under IAEA safeguards, but a number of important omissions exist, including India, Israel, Pakistan, and South Africa. In general, the developed nations, particularly those possessing nuclear weapons, encourage IAEA's safeguard mission, whereas the less developed nations consider IAEA primarily as a source of nuclear assistance and regard safeguards as a quid pro quo for assistance. Several nations actively oppose the IAEA's role in nonproliferation, claiming that it interferes with the development of indigenous civil nuclear industries. CWC drafters could also consider the "carrot and stick" approach as the focus of CW negotiations shifts to CW nonproliferation from the earlier concentration on East-West concerns.

CONFLICTING INTERESTS OF NORTH AND SOUTH

The conflict between IAEA's goals of promoting and controlling nuclear technology has emerged as a major source of North-South contention. As in other international and UN-related institutions, developing nations increasingly have organized to assert their interests. There has thus been a shift from virtually absolute East-West control by the major powers (who largely fund IAEA) to a situation in which the Group of 77, an organization of Third World and nonaligned nations, has attempted to control the Board of Governors, capture key staff positions, and emphasize nuclear promotion rather than

safeguards activities. The increased number of staff positions that are filled by nationals of developing nations may be a consequence of the increasing political strength of this group.

In terms of the CWC analogy described earlier, the U.S. Draft and the Rolling Text differ from IAEA safeguards by not including provisions for actively promoting chemical technology. The resulting single focus on verification may diminish incentives for certain less developed nations to become signatories, but it also reduces the likelihood that verification activities will become subsidiary to technology transfer and technical assistance.

Nevertheless, the formation and evolution of organized voting blocs to promote the interests of less developed countries can be expected in a multilateral organization. If this occurs, the chemical treaty organization will, like IAEA, be under considerable pressure to balance technical abilities against political realities in its selection of professional staff.

TECHNICAL COMPETENCE

Until recently, IAEA safeguards could be faulted because of their failure to employ adequate containment and surveillance technology and their reliance on inspectors who were spread too thin technically. The IAEA, in response to these criticisms and others, improved the training of inspectors, raised the level of functional specialization, and generally expanded its mastery of technology with assistance from the United States and other advanced nations who support an active program of safeguards-related research and development. It has also been suggested that the broadening of the geographic distribution of inspectors has led to an increasingly mechanical approach to on-site inspection that relies on highly detailed and structured protocols based on elaborate checklists. Inspectors are not encouraged to write about their "gut feelings" regarding possible anomalies or to pursue investigative leads, and they may be subject to rigorous cross examination by superiors should they imply that untoward or even illicit activities have occurred.[4] Furthermore, inspectors who seem too highly qualified may be suspected of engaging in industrial espionage.

In the CWC example, a similar set of issues needs to be resolved, as follows: the proper balance between specialization and general expertise, the tension between political realities and technical criteria in selecting staff, the degree to which inspection protocols are rigidly

[4] L. Scheinman, seminar at The RAND Corporation, October 7, 1988.

programmed vs. the ability to follow new leads, access to expertise in state of the art (or less advanced) monitoring technology, the duration and nature of the required training, and most important, the qualifications of the inspection staff. If the IAEA experience is a guide, all these issues could result in contentious debate.

LESSONS FROM THE IAEA SAFEGUARDS EXPERIENCE

Like the proposed CWC regime, the nuclear safeguards system is international in scope, and includes reporting and on-site inspections for civilian nuclear facilities. A number of studies (Scheinman, 1987, Fischer and Szasz, 1985) have reviewed the recent history of the Safeguards program, and congressional hearings (Committee on Foreign Relations, 1979; Committee on Foreign Affairs, 1982; Committee on Foreign Relations, 1988) have elicited testimony and other information that bear on its effectiveness and shortcomings. However, it appears that the Safeguards program has not been comprehensively evaluated to permit objective analysis of its effectiveness. For the most part, public attention is focused on IAEA only when diversions or breakdowns are reported to have occurred (Richter, 1981a,b), and the IAEA preserves a blanket of confidentiality that makes it difficult to gather data for assessment of its operations. Until recently, those who have written about IAEA have generally been instrumental in its development or may have felt the need to protect the organization as it established itself. Others, who might otherwise be critical, may temper their public remarks to preserve access to the organization. Even advocates believe that after 30 years of safeguards, the agency is now ready to be evaluated from an unbiased perspective. Data gathering for such an evaluation would be hampered by the agency's control of relevant data, but other sources may exist.

As far as understanding the organization and its abilities, we know something about the IAEA's institutional structure (Appleby et al., 1986; Sanders, 1985) and the methods that it uses in inspections (Imber, 1983), but we lack adequate knowledge of its inner workings, decisionmaking, and the effectiveness of both its formal and "informal" verification modalities. By informal modalities,[5] we mean the network of inspectors, officials, and nations who exchange ideas and findings about suspicious occurrences in ways that may violate IAEA nondisclosure oaths—a useful conduit for information flow outside of the formal IAEA channels. This informal approach provides an alternative to the

[5]The notion of informal verification was brought to our attention by an ex-practitioner of nonproliferation policy.

tight lid of confidentiality imposed by IAEA. Paradoxically, it may promote the goals of nonproliferation.

Periodically, when an unusual proliferation-related event occurs, a partial window is opened on the IAEA. As discussed in succeeding sections, this window was opened slightly during the early 1980s when congressional hearings investigated the circumstances surrounding the Israeli bombing of an Iraqi reactor.

Before proceeding further, we first describe the goals of arms control verification and the general manner in which the IAEA seeks to achieve them.

GOALS OF VERIFICATION

As generally understood, arms control verification has three accepted goals: To detect violations (by rigorous accounting, policing, and monitoring), to deter noncompliance (by increasing the risks of detection and thus raising both the real and political costs of cheating), and to build confidence (by demonstrating that states are abiding by their treaty obligations). A collateral result of verification, intended or not, could be to gather intelligence (both national security and industrial), and in this way to act as a vehicle for technology transfer. It is this collateral function that most concerns the chemical industry in the CWC context. As we shall indicate, a number of procedures have been written into the IAEA safeguards process to deter intelligence gathering and technology transfer, and we suggest that a similar set of procedures should be involved in CWC verification. These procedures cannot guarantee success. It is their implementation, in practice, that determines how well the IAEA or its chemical weapons counterpart is able to carry out its legitimate work with minimal loss of collateral data.

IAEA safeguards are generally useful in confidence-building. Their value in the past in detecting violations and deterring noncompliance is problematic, and their future value is even more clouded if present trends continue. For the CWC organization to be successful in verification, it may require more rigorous (and intrusive) data gathering and on-site inspection protocols than does IAEA, which does not act as an international police force. The protocols could also offer more opportunities for the collateral loss of industrial materials and trade secrets than exist in the nuclear case.

The balance between transparency and opacity helps to determine the effectiveness of a verification system. If too transparent, the system could function until it becomes highly politicized and is ultimately

perceived as a conduit for intelligence gathering, technology transfer, or a forum for partisan rhetoric. If the system is overly opaque, security conscious, and preoccupied with avoiding disputes, it could lose any ability to apply meaningful political pressure. An excess of confidentiality could make more difficult the work of informal verification, outside the agency, that serves the various competing nonproliferation objectives of individuals and nations.

INTENT OF ON-SITE INSPECTION

On-site inspections are intended to verify the validity of information submitted to the IAEA. The IAEA inspection system is *not* intended to police or otherwise detect material or facilities that are undeclared and hence not safeguarded; it is restricted to the verification of declared inventories of nuclear material, to detect in this way the diversion of safeguarded material or the misuse of a safeguarded facility. For the CWC to be effective, policing and investigative activities that surpass IAEA's may be required.

IAEA safeguards distinguish between signatories to the Nuclear Non-Proliferation Treaty (NPT) and nonsignatories to the extent that *all* peaceful nuclear materials and facilities in NPT states are covered, whereas only *designated* nonmilitary facilities and materials are covered for non-NPT states. NPT states are subject to a national system of accounting, international inspections, and audits, whereas non-NPT states are required to submit only specific data that are agreed upon between supplier states, the recipient, and IAEA.

NPT inspections are of three types: routine, to verify that state-submitted reports are consistent with the accounting and operations data maintained by the facility operator; ad hoc, to verify information concerning the design of new nuclear facilities; and special, to collect additional data or when unusual events warrant IAEA interest.

U.S. OBLIGATIONS UNDER IAEA SAFEGUARDS

It is useful to understand aspects of the implementation of IAEA safeguards in the United States that might assist in formulating an effective system for implementing the CWC. To facilitate this understanding, we review pertinent aspects of the U.S./IAEA treaty, its reception by the Senate during ratification hearings, and the regulations and procedures adopted by the government to comply with the treaty while still deferring to the wishes of Congress, including the formally stated goal of preventing collateral loss of sensitive material.

Sensitive material, in the context of IAEA safeguards, refers to national security sensitive, proliferation sensitive, and commercial sensitive. It is the latter category, we believe, that is most pertinent regarding the proposed CWC.

The IAEA and individual nations negotiate separate safeguard agreements that mandate a set of domestic implementation procedures whose adequacy is to be determined by the IAEA. The United States, as a nuclear weapons state, is not subject to safeguards and controls that are as wide-ranging for nonnuclear weapons signatories to the Non-Proliferation Treaty. Only U.S. facilities that are not directly involved in national security activities are subject to safeguards, there are no limitations on U.S. use of nuclear material, and the United States has sole authority to decide which facilities are subject to safeguards. Given these restrictions, it seems clear that the value of the U.S.-IAEA safeguards agreement is largely symbolic: to demonstrate that the United States as a nuclear weapons state is willing to bear burdens of safeguards and reporting like those imposed on nonweapons nations and that the civil nuclear industries of all states will be similarly treated.

A domestic safeguards program was already in place prior to the U.S.-IAEA agreement. Following the IAEA agreement, the United States was required to establish a suitable system of nuclear material accounting and control that was consistent with agency policy; submit to IAEA a list of government and commercial facilities that were eligible for IAEA safeguards (excluding facilities of direct national security significance); collect design, inventory, and operating data from facility operators as required by the agreement and protocols; forward the requisite data to IAEA for the agency to select several reactors and/or processing plants for full safeguards treatment; negotiate with IAEA (with advice from the facility operator) over the appropriate procedures and locations for on-site inspections within facilities chosen for safeguards; require operators to open their facilities to inspections by IAEA officials accompanied by U.S. Government observers; and explain or correct anomalous findings that arise during the IAEA verification process.

ACCOUNTING, CONTAINMENT, AND SURVEILLANCE

For NPT states, safeguards depend on nuclear materials accountancy to determine quantities of nuclear materials, and containment and surveillance to reduce the probability of undetected movements. This may involve devices such as special seals, video monitors, and

observation posts to monitor the movement of materials, and thus deter diversion by increasing the risk of early detection. The NPT (Article III) refers to "preventing" diversion, whereas safeguard agreements between individual states and the IAEA refer to "detecting" diversions, a distinction that may illustrate a subtle change in intent when goals are set into practice.

ISSUES RAISED DURING THE IAEA RATIFICATION HEARINGS

Legislative History

The legislative history of the Senate ratification of the U.S.-IAEA Safeguards Agreement offers insights into potential issues pertaining to CWC ratification. Since questions that were raised by the Senate, and responses by the Executive Branch could have similar CWC counterparts, despite political and substantive differences, the various precedent-setting aspects of the U.S.-IAEA treaty may be useful in preparing for CWC ratification.

Nonnuclear-weapons signatories to the NPT agree to accept IAEA safeguards on all peaceful nuclear activities. The United States signed the NPT in 1968, but was criticized by nonweapons signatories for not being required to hold to the provisions of the treaty and thus possessing a commercial advantage. In 1967, President Johnson announced a policy that permitted application of IAEA safeguards at U.S. facilities, excepting those of direct national security significance. This policy was reaffirmed by Presidents Nixon, Ford, and Carter, and an agreement between IAEA and the United States was signed in 1977 to formally implement the policy.

The agreement was submitted to the Senate for ratification in 1978. Two hearings were conducted by the Senate Foreign Relations Committee in 1979, and the Committee reported it to the Senate with no negative votes in the summer of 1980. The full Senate ratified it shortly afterwards. Although the Foreign Relations Committee endorsed the treaty without formal reservations, three major areas of concern were noted—national security, protection of U.S. industry, and the legal and administrative relations among the various agencies involved in treaty implementation. These concerns were translated into several understandings among the Senate, the Executive Branch, and the NRC, largely in response to testimony by Senator McClure of Idaho who raised a series of objections to the treaty and to the Carter administration's handling of the ratification and implementation process.

These understandings (Committee on Foreign Relations, 1980) are described below:

National Security. The President was to notify Congress of any proposed new facilities to be added to the list subject to IAEA jurisdiction, and Congress could disapprove by joint resolution if it believed that the facilities had direct national security significance.

Restricted data, as defined by the Atomic Energy Act of 1954, and including data on the design, manufacture, or utilization of atomic weapons, were not required to be communicated to the IAEA.

Legal and Administrative Relations. The President was to maintain an interagency mechanism, including Executive Branch agencies and the Nuclear Regulatory Commission, to coordinate policy and resolve disputes pertaining to the U.S.-IAEA Treaty, and Congress was to be kept informed of the operation of this mechanism.

While the existing authority and responsibility of the Nuclear Regulatory Commission was not to be limited, the NRC should seek and be bound by guidance from the President regarding any questions of interpretation.

Protection of U.S. Industry. Prior to negotiations with IAEA concerning the specific procedures for inspection of their facilities, concerned licensees were to be consulted and their views taken into account.

Legislative vs. Administrative Approaches

Although he endorsed ratification, Senator McClure also recommended that the ratification resolution include a reservation that the Agreement's entry into force be delayed until additional implementing legislation had been enacted. The response of both the Carter administration and the Democratic majority on the Senate Foreign Relations Committee was that such legislation was not required, that McClure's reservations could be handled more efficiently through amendments to existing NRC regulations than through the legislative process, and that the 1954 Atomic Energy Act and later amendments provided sufficient legislative authorization for the Atomic Energy Commission (AEC) (and its successor organizations—the Energy Research and Development Administration, the Department of Energy, and the NRC) to administer domestic implementation of the Agreement.

Ultimately, McClure lost. The administrative rather than the legislative path was followed and the Code of Federal Regulations (CFR) was amended to include rules for implementation. Had McClure's proposed reservation been accepted, additional hearings and more active congressional participation in the implementation process by both

Houses would have occurred. The hearings would have provided a forum for objections to be raised regarding both the U.S. implementation of the treaty and (perhaps more importantly) other nonproliferation policies of the Carter administration.

Earlier both the Administration and the NRC consulted with industry and posted a series of proposed implementing regulations in the *Federal Register*. The nuclear industry supported ratification, as indicated by written testimony submitted by trade associations, utilities, industrial firms, and others.

In short, Senator McClure's concerns (see below) regarding private firms were not shared (at least publicly) by the nuclear industry, and the industry did not endorse his request for further legislation.

IAEA Safeguards' Possible Impact on Industry

Senator McClure's comments (during the Foreign Relations Committee Hearings of December 1-3, 1979) on the possible negative impact of the IAEA Agreement on the U.S. nuclear industry could, with only slight modification, be applied to the chemical industry in the course of future CWC ratification hearings.

> Commercial nuclear facility operators already face an increasingly demanding burden to meet domestic requirements for public health and safety, physical security and domestic safeguards, among others. If implementation of the treaty added a significant and unpredictable additional regulatory burden with international requirements on those operators, particularly in the context of regulation to meet nonproliferation and foreign policy objectives, and in the absence of traditional administrative due process procedures and protections, the incremental increase in the total regulatory burden on operators could very well serve to deter future development of nuclear power.
>
> Also, the potentially severe requirements of implementing regulations as applied to research and development projects, coupled with the potential insecurity of commercially-sensitive proprietary information and trade secrets could be expected to deter both private and government sponsored nuclear R&D.
>
> Similarly, the predictable operation of our Nation's nuclear power plants should not be inhibited by our apparently arbitrary requirements for access, inspections, notice and reporting.
>
> The NRC and the State Department, through the proposed regulations, such as the design information questionnaires and the facility attachments, continue to undervalue the importance to the country of commercially-sensitive technology and proprietary information.

After nearly a decade of IAEA safeguards in the United States, reactors that possess few commercially sensitive features have, until recently, borne the brunt of IAEA inspections.

CWC'S CORRESPONDING IMPACT ON THE CHEMICAL INDUSTRY

Despite the fundamental differences between the nuclear and chemical industries, a number of domestic implementation requirements for the CWC seem strikingly similar to those for nuclear safeguards. Because of these differences, and "generic" objections like those raised by Senator McClure, a potentially more contentious debate could arise during CWC ratification hearings than for IAEA safeguards. It could also be viewed that CWC implementation poses greater risks to certain industry sectors than does the nuclear agreement.

Points that could be made by industry and congressional critics during future CWC-related hearings are that U.S. implementation is likely to be more rigorous than other nations' and, as a consequence, the international competitiveness of the U.S. chemical industry would suffer; that virtually every significant operation of the nuclear industry is performed in accord with statutory (NRC/AEC-authorized) licensing requirements, whereas in the chemical industry such blanket licensing requirements do not exist; government intervention in chemical industry operations pertains to specific matters of health, safety, and the environment (as described earlier) and not to any overriding legislative control of chemical manufacturing and distribution as in the nuclear industry; a domestic nuclear safeguards system was already in place for U.S. facilities that required only minimal modifications for IAEA safeguards because IAEA safeguards are based on the same principles of nuclear material accounting used in the United States; and that the U.S. national system of nuclear inventory was generally more stringent than that of the IAEA, whereas chemical reporting is both more fragmented and less complete in a number of important ways than the potential requirements of the CWC.[6]

Finally, the segment of the U.S. chemical industry that deals with CWC-related materials includes a number of smaller firms for whom the burdens of compliance can be proportionately more onerous than

[6]An issue not addressed during the IAEA hearings has recently surfaced. Operators of certain civilian nuclear facilities claim that their declared eligibility for IAEA safeguards and on-site inspection has weakened their competitive status with regard to sensitive or "black" programs that they seek to initiate, and the government should indemnify them against loss of business in keeping with their Fifth Amendment rights (L. Scheinman, seminar at RAND, October 7, 1988).

for larger firms. Unfortunately, the small firms are virtually invisible and are often not able to enter into the formal dialogue that will ultimately produce a protocol for U.S. implementation of the CWC. The formal dialogue traditionally consists of comments on *Federal Register* rule-making notices, testimony before government agencies and legislative committees, and ultimately, legal initiatives to modify regulations. Small firms are more likely to engage in only occasional participation in trade association committees such as the CMA Phosphorus (now Chemical Warfare) panel, a few discussions with government officials, letter writing, and telephone calls to gain the attention of elected representatives. Congress could be responsive to the small-quantity chemical manufacturers, processors, distributors, and other smaller firms affected by the treaty, and minimize additional burdens on them. On the other hand, the growing concerns over the proliferation of CW capability and the possible role of the distribution network in diverting legitimate chemicals and technology to illicit uses could result in smaller firms being subject to even greater burdens than described here.

THE U.S.-IAEA AGREEMENT AND ITS IMPLICATIONS

We next briefly review the U.S.-IAEA agreement to highlight implementation procedures that could offer useful precedents for the CWC. Fischer and Szasz, Scheinman's two reviews, and the U.S. Code of Federal Regulations have been useful sources of information, as well as the Congressional Research Service and material from IAEA.

The general purpose of IAEA safeguards in the United States, as in other nuclear weapons states, is to demonstrate a willingness to share the burdens of IAEA oversight on civilian nuclear activities with no direct national security significance, particularly fuel rod fabrication, reprocessing, and power generation. This willingness is intended to convey to nonweapons states that they would not be placed at commercial disadvantage because of IAEA oversight and to thus encourage wider adherence to the NPT. As we noted, U.S.-IAEA safeguards are largely symbolic. Although the specific objective of the agreement is the timely detection of withdrawals (other than those permitted by the agreement) of significant quantities of nuclear material that have been placed under IAEA jurisdiction, the IAEA can apply safeguards only to those facilities that the United States declares eligible. Also, military-related facilities and materials are exempt and the United States may withdraw nuclear material from eligible facilities at any time. In addition to safeguards, the United States is obligated to report data on

nuclear material imports and exports. In the light of the many limitations on IAEA safeguards, the effectiveness of the Safeguards program in the United States and other weapons states must be judged using criteria that differ from those applied to nonnuclear weapons states.

Thus, nonproliferation is a less important criterion than demonstrating that U.S. public and private facilities share the safeguards burden with facilities in nonweapons states and in this way derive no unfair commercial advantage in world markets.

Appendix E describes how IAEA safeguards are implemented in the United States.

PROPRIETARY MATERIAL

The treatment of confidential material is an important issue for IAEA. Both the statute governing the creation of the IAEA and the agreements between the agency and individual nations forbid disclosure of confidential proprietary material. The IAEA statute requires that staff are not to seek or receive instructions from outside the IAEA, nor are they to disclose any industrial secret or other confidential information coming to their attention in the course of their duties.

According to W. Donnelly of the Congressional Research Service, a long-term student of IAEA activities, no reported incident of loss of industrial material had occurred as of mid-1987, nor had there been any formal action taken against an inspector accused of passing information to persons other than the appropriate authorities. The Agency does not have an internal security capability sufficient to ensure that the provisions for confidentiality are enforced. Leaks of sensitive information can theoretically occur directly from an inspector or from the secretariat that reviews reports written by inspectors. Hearsay evidence exists regarding a number of breakdowns in the security system for protecting proliferation-sensitive or proprietary material. It is also true that the nonproliferation regime may be strengthened by IAEA officials operating informally, in violation of IAEA rules, to alert their colleagues and others of suspicious activities.

We have discussed these points with former inspectors and others who monitor safeguards operations. Their opinions regarding the collateral loss of commercially sensitive material range from "IAEA inspections are a license to steal" to "too early to tell." They also have suggested that the possible loss of trade secrets is not a major problem in the United States, but may become more acute as fabrication and enrichment plants become the focus of inspection. Until recently, U.S. inspections have concentrated on reactors that have few commercially

sensitive or unique characteristics. The former inspectors also suggest that the Europeans, particularly West Germany and France, believe that IAEA is a conduit for technology transfer.

The conditions of employment for inspectors could influence the extent of compliance with the terms of the statute regarding conflict of interest. Professional salaries and benefits are comparable to those for other international civil servants (and correspondingly tax free), but there are few long-term inspectors and the permanent staff is small. There are somewhat fewer than 200 inspectors. Employment contracts are usually for two years, with a high likelihood of a second two-year contract. Five-year contracts may be offered to inspectors who have satisfactorily completed the first four probationary years. It has been suggested that inspectors who wish to enter or reenter the commercial or government sector upon completion of Agency tenure may be susceptible to potential conflicts of interest and could be tempted to engage in industrial or conventional espionage. If the Agency is to maintain credibility as more (proliferation-sensitive and proprietary) facilities are subject to full safeguards, an active internal security program may be required to encourage high standards of inspector (and other staff) reliability, and to inspire confidence that safeguards are not a conduit for technology transfer. Even more than other international organizations, IAEA operates in a realm where loyalties are divided and potential opportunities exist for conflicts of interest. Furthermore, both the rewards and risks are sufficiently large to require that questions of staff reliability and internal security issues be taken seriously.

The IAEA controls access to information that can be used to assess safeguard inspector performance, including instances of bias, collateral technology transfer, and conflicts of interest. It is therefore difficult to extract from the public record how problems that may arise during CWC inspections could benefit from the IAEA experience, and whether the employment policies outlined here should be used as a model for the CWC. A mechanism for gathering objective data for these purposes needs to be established if the CWC is to benefit from the history of IAEA successes and failures.

INFORMAL VERIFICATION

During 1981 and 1982, a window was opened on the inspection activities of the IAEA and the informal verification network during congressional hearings following the July 1981 Israeli bombing of the French-built Iraq reactor. E. Morgan, a former inspector, reported on

technical shortcomings of the IAEA safeguards system, and Roger Richter described his personal experiences in Iraq. Richter, a U.S. national who had served as an IAEA inspector, disclosed several disconcerting aspects of IAEA policy and procedures during congressional testimony (Morgan, 1982; Richter, 1981a,b).

> Since 1976, all inspections performed in Iraq have been conducted by Soviet and Hungarian nationals. Recently, a French national was granted approval by Iraq to be an inspector, but he has not, as of yet, been to Iraq to make an inspection. This is a reflection of the fact that countries have the right to veto inspectors from whatever countries they choose, a right which they regularly exercise. As an accepted inspector, you must keep in mind that any adverse conclusions you might reach as a result of your inspection would have to take into account your country's sensitivity to how this information might affect relations with Iraq. In preparing for the inspection, you must first give the government of Iraq several weeks notice of your planned inspection and obtain a visa. They may agree with the date or could, as has recently been the case, suggest you postpone or change your plans to a more suitable date. Naturally, not wanting to create unnecessary friction, you will agree.

Richter's testimony confirms that inspectors are expected to avoid confrontation and that the host country can seriously restrict access and timeliness. Scheinman (seminar at RAND, 1988) recently described a number of other possible attempts at restricting inspector access by violence or threat of violence.

LIMITED TECHNOLOGY AND UNCOOPERATIVE HOSTS

Richter commented on the technical limits placed on inspection effectiveness by IAEA's (then) weak grasp of surveillance and monitoring technology combined with Iraq's unwillingness to provide the technical support it was obliged to deliver under its agreement with the IAEA. He also observed critical gaps in the information provided to the IAEA by Iraq as part of its duty as an NPT signatory. These gaps and other information implied that Iraq could acquire a stockpile of plutonium sufficient to make several atomic bombs in sensitive facilities within a nuclear reactor complex that Iraq had declared. The relative infrequency of inspections would permit illicit clandestine operations that could be covered up prior to inspection. The inspection assignment itself was quite narrowly focused, and the most sensitive facilities could escape safeguards. The inspection and inventory audit were highly restricted, relying entirely on the willingness of the inspected party to declare all its pertinent facilities and material.

At the time of Richter's testimony, it was suggested that inspectors from the Warsaw Pact had alerted Richter to possible illicit activities occurring elsewhere in the reactor complex. Richter was upset by operational restrictions that compelled him to ignore clandestine activities potentially occurring in nearby facilities that were excluded from inspection. His concerns led him to prepare a report on the Osirak reactor for U.S. Mission to IAEA in clear violation of the Agency rules of nondisclosure.

The IAEA and others reviewed Richter's testimony and clarified or corrected several technical details, but even Richter's critics agreed that safeguards effectiveness relies on the cooperation of host nations and their desire to comply with both the spirit and letter of the Safeguards Agreement. Visa delays, accidents, and spurious and real safety concerns are other methods by which uncooperative host nations and facilities can obstruct the goal of effective inspections.

Although only a few inspectors have gone "public" about possible noncompliance by signatories, it is generally believed that IAEA inspectors and staff are likely to report suspicious activities to their own governments and perhaps others as well, in violation of their conditions of employment. As noted above, these activities form the basis of an informal (and illicit) verification network that paradoxically may promote the goals of nonproliferation. They could also become a major source of illicit technology transfer.

IS THE IAEA MODEL APPLICABLE? COSTS VS. BENEFITS

If the U.S. goal in agreeing to IAEA safeguards was to signal that it would share an onerous burden and not derive unfair commercial advantage from its possession of nuclear weapons, then that rather limited goal was met. After 30 years of IAEA inspections and eight years of IAEA safeguard activities in the United States, it is still not possible except in a general way to assess the global costs and benefits. Even the most severe critics believe that the NPT and IAEA safeguards may have helped prevent nuclear proliferation, but other political factors coupled with the inherent complexity of nuclear weapons technology may have more impact on the limited spread of nuclear weapons. It is agreed that the benefits of international safeguards have been symbolic and confidence-building, but we cannot tell to what extent they have deterred diversions and detected violations. Certainly many countries still appear to be seeking the nuclear option. If the costs of joining the nuclear club are too high, nations could seek CW capability as a deterrent to an adversary's nuclear force.

Exploring the cost side of the cost-benefit ratio for U.S. compliance with IAEA safeguards leads to several qualitative observations. The actual practice of safeguards seems decidedly less intensive and intrusive than either the IAEA statute or the agreement between the United States and the agency would suggest. The treaty provisions for special inspections have not been invoked, nor has the agency invoked its virtual challenge rights as established in its statute to have "access at all times to all places and data and to any person who by reason of his occupation deals with materials, equipment or facilities which are required by this statute to be safeguarded. . . ." Further, actual inspections are considerably less stringent than those permitted by the agreement, and the special U.S. provisions for protecting against loss of commercially sensitive design or other data have not been requested by U.S. industry, presumably because the reactors which were the first objects of U.S. safeguards involve little commercially sensitive material. As commercial fuel fabrication, processing, and enrichment plants are safeguarded, the situation regarding sensitivity to the loss of commercial data may change. A new issue seems to be surfacing—the impact on the business competitiveness of commercial facilities that may later wish to engage in sensitive national security activities but have already been declared eligible for safeguards and could be exposed to foreign inspectors.

A DIPLOMATIC APPROACH TO VERIFICATION

From the anecdotal information that we and others have gathered, a rather cloudy picture of the IAEA emerges. Generalizations are risky, but it appears that IAEA seeks to resolve anomalies out of the political limelight rather than by using the authority given it by treaty. An informal verification network also exists that from time to time violates IAEA regulations against disclosure but whose operation could paradoxically promote the goals of nonproliferation. A similar network, we contend, could be used for illicit technology transfer.

In practice, IAEA safeguards involve a series of negotiations between the Agency and the signatory nations that essentially "hand tailors" treatment to the individual country and facility. In the Euratom region where there is maximum concern about sensitive material, IAEA observes technicians but is not involved in "hands on" activities. In the United States, where NRC domestic inspections have traditionally emphasized physical security and not diversion, IAEA staff operate in a "hands on" role and are monitored by NRC officials.

There is no explicit challenge provision. Countries are free to designate only those facilities they wish to if they are not parties to the NPT. Unannounced inspections within a specified time period are theoretically possible, but there is no evidence that short notice visits have ever been requested or granted. Access to a country and a facility can be delayed beyond the times required for effective verification of nondiversion; it may require 7-10 days to reach a site, and nations may not waive their visa requirements. Inspections may therefore be hindered in precisely those instances where there is most likelihood of diversion to weapons. The United States and other nuclear weapons states have great leeway in declaring facilities eligible for safeguards. The Soviet Union, for example, recently nominated an uninteresting (from a safeguards perspective) power reactor; it was inspected by an IAEA team that included a U.S. citizen. For East-West confidence-building, West European governments have accepted inspectors from Eastern Europe and the Soviet Union.

Since inspectors must be approved by the inspected country, the Agency, in the interests of harmony, could select inspectors expected to be granted easy access rather than inspectors who are likely to perform rigorous inspections. In this regard, for years Iraq accepted only Hungarian and Soviet nationals to inspect the Osirak reactor that was ultimately bombed by Israeli aircraft.

An ominous trend is the "leveling down" of inspector skills and initiative, perhaps associated with the requirement to achieve broad geographical representation. Another negative factor is the increasing reliance on inflexible and detailed inspection protocols, with little motivation or opportunity for inspectors to discover or follow-up suspicious leads.

The survival of the IAEA safeguards in the presence of both East-West and North-South differences is aided by its highly diplomatic and nonadversarial approach and its avoidance of the political limelight. This approach is encouraged by a Board of Governors that acts by consensus and is not willing to make public accusations of noncompliance. It is also assisted by the unwillingness of IAEA to serve as an international policeman.

On balance, the incremental costs to the U.S. nuclear industry and government of complying with NPT and U.S.-IAEA safeguards are limited, both in economic terms and in terms of intrusiveness and additional regulatory burden. This is not surprising since every aspect of the nuclear industry is both licensed and heavily regulated, and U.S. protocols for complying with the IAEA Safeguards program are built on 30 years of similar controls by the AEC and NRC. A domestic nuclear program already included such concepts as material balance

areas and inventory or flow key measuring (strategic) points, and required regular submission of material accounting, control and operating data, and various types of design data. This made it relatively easy to comply with the reporting requirements of the treaty. For example, NRC data could be reformatted for submission to the IAEA. Proprietary data do not (yet) appear to have been jeopardized and major problems have not yet arisen during inspections of U.S. facilities.

A SIMILAR APPROACH FOR THE CWC?

It is interesting to consider how the U.S. chemical industry would respond if the CWC verification regime entailed the same level of monitoring intrusiveness that exists in the nuclear case. The chemical industry is regulated by a number of agencies, but is not licensed by any chemical equivalent of the NRC. Further, it has evolved a tradition of active vigilance concerning additional regulation. There is no chemical counterpart to the comprehensive preexisting system for collecting data similar to that required by the IAEA. Although the Environmental Protection Agency (EPA) gathers some data similar to those required for the CWC, the relationship between EPA and the chemical industry differs significantly from the relationship between NRC and the nuclear industry. For example, the chemical industry has challenged EPA's attempts at comprehensive data collection in a single reporting instrument (CMA, 1987). Conversely, it is also concerned about the adequacy of EPA's data processing ability to accurately link data from different sources to develop comprehensive regulatory databases. Another difference is the emphasis that the chemical industry places on protecting commercial material. In addition to trade secrets, the confidentiality of capacity and production data is taken very seriously by industry for purposes of estimating market share and other critical business parameters.

We are not able to estimate the "leakiness" of confidential information for IAEA compared to EPA. The chemical industry believes that data it submits to EPA as confidential business information (CBI) becomes public knowledge within three years, presumably as a result of inadequate EPA security. We cannot estimate the analogous time for an IAEA-like organization, but we suspect that it would be in the same range or even shorter, particularly since the IAEA does not have many self-policing, enforcement, or internal security activities. Furthermore, an employment policy based on short time appointments rather than career tracks might pose a greater risk of losing proprietary material.

We suggest that the IAEA experience is instructive and that a number of IAEA safeguards-related procedures should probably be considered as part of the domestic implementation of the CWC. However, we are not convinced that an IAEA-like approach to chemical weapons verification is likely to prove satisfactory in a world where 30 states already possess or seek to possess CW capability. If nuclear weapons have spread more slowly than many predicted, it is mainly because of the intrinsic complexity of the technology, a number of significant political factors, and the severe restrictions that individual nations may place on nuclear technology transfer. For CW, verification that is rigorous and perhaps even more confrontational may be required.

QUANTITATIVE GOALS: NPT VS. CWC

Before comparing goals and to better comprehend the magnitude of nuclear safeguards activities, we note that nuclear fuel is generally 4 percent enriched and not directly usable for weapons. However, low enriched uranium fuel can, after being used in a reactor, generate reprocessed plutonium for weapons use. Thus plutonium, high enriched uranium, and, to a lesser extent, low enriched uranium are subject to safeguards. Using 1984 data, the total amount of safeguarded material worldwide consisted of 150 tons of plutonium and enriched uranium, 23,000 tons of low enriched uranium, 32,000 tons of source material, and 1400 tons of heavy water. Nearly 900 installations were subject to IAEA safeguards, and 150 inspectors carried out some 1800 inspections of these facilities (Scheinman, 1987). The corresponding quantities for the chemical program have not yet been established, but will certainly depend on the scope and rigor of the final treaty documents.

The overall objectives of IAEA safeguards are the timely detection of the diversion of significant quantities of nuclear material from peaceful activities and the deterrence of such diversion by risk of early detection. Given these qualitative objectives, what are the quantitative goals for nuclear materials and what should the analogous goals be for the proposed CWC? An important issue in both verification regimes is whether quantitative objectives should be consistent with a realistic ability to monitor, detect, and verify, or whether they should be set at ideal levels that may not be attainable in practice.

The IAEA's notion of "timely detection" is related to the time required to convert nuclear material to a form suitable for a nuclear explosive device (7 to 10 days in the case of plutonium to a year for low enriched uranium); "significant quantities" are related to the

critical mass of material required for an explosive device (8 kg for plutonium to 75 kg for low enriched uranium); and the "risk of early detection" is specified as a detection probability greater than 90 percent and a false positive rate of 5 percent.

These quantities are more ideal than real and are not intended to correspond to the actual achievements of the Safeguards program. Furthermore, the probabilistic specification of the risk of detection is in the tradition of nuclear probabilistic risk assessment, lacking any empirical basis for estimation.

For chemical weapons—where a single munition has limited impact and there is no "critical mass"—a plausible approach is to introduce the concept of a "militarily significant quantity," defined on the basis of a particular scenario or set of scenarios. For example, the present world CW arsenals are probably of the order of 10^5 tons. Quantities that are perhaps one-tenth of this could certainly be important or even decisive in a European conflict. Moreover, scenarios of varying plausibility may be constructed in which quantities as small as hundreds or a few thousand tons of CW agents delivered against critical NATO targets could be significant in a Warsaw Pact-NATO war. Significant quantities could be far smaller in a conflict between regional adversaries of less than major power status. Further, the political implications of the use or threat of use of even smaller quantities of CW against major power forces in a limited conflict could be far more significant than the likely battlefield effects. A politically significant quantity could thus be much less than a militarily significant one. Estimates of significant quantities are sensitive to the assumed degree of chemical protection, training, and readiness and also to whether offensive use of CW is intended to produce casualties (large quantities) or degrade operational effectiveness (smaller quantities). Since CW scenarios and the quantities associated with them vary widely, it may be difficult and perhaps inappropriate to choose a single figure of merit as a goal for verification.

Another complicating factor is that Schedule III chemicals such as phosgene and hydrogen cyanide are no longer taken seriously as chemical weapons by developed nations but could be employed by less developed countries against poorly prepared civilian and military targets. If the world production of phosgene is in the billions of pounds range, and typical chemical material balance practices (in the West) are accurate to within about 5 percent, an intrinsic uncertainty of thousands of tons of Schedule III chemicals could exist, quantities that might be militarily significant under certain circumstances.

Since world production of key precursors is probably in the millions of pounds range, mass balance uncertainty alone could mask several

hundred tons of material that might be diverted to illicit use without being detected through material accounting. Although this is a large quantity, it seems far more manageable than the thousands of tons of Schedule III chemicals that would fall below the precision threshold of material accounting.

It seems desirable that "timely detection" should be related to the position in an illicit pipeline that a potential cheater would need to establish. Presumably, the frequency of monitoring and OSI should be highest for facilities that are closest to use. Thus, facilities that are known to have produced or stored chemical munitions should be visited far more frequently than former CW production plants, and key precursor sites might be visited less frequently than declared agent production facilities.

As far as the "risk of detection" is concerned, detection probabilities as large as those cited for nuclear safeguards seem plausible; there is no empirical way to determine them.

In summary, quantifying verification goals for the case of CW seems more complex and scenario dependent than in the nuclear case. Given the evolution of interest in the CWC and the growing recognition of the roles that CW can play for less developed nations, it seems that a single verification goal of perhaps tens of tons of agent equivalent would be sufficiently low to encompass virtually all militarily significant quantities but a goal of this level would be unattainable among developed nations possessing many chemical industries and associated infrastructures.

A potentially more measured approach, but one not likely to be acceptable politically, is to specify qualitative or a range of quantitative verification objectives in the formal treaty documents but to negotiate specific goals in the individual agreements between signatories and the treaty organization. The quantitative goals would reflect the level of industrial development and the regional context in which the signatory exists. Thus, a verification objective equivalent to hundreds of tons of agent may be suitable for Warsaw Pact or NATO members, whereas an objective of tens of tons may be suitable in Central America or Southwest Asia. Such a case-wise approach, while desirable from the viewpoint of matching goals to reality, would be hard to negotiate because of the appearance of discrimination against less developed nations, and the existence of situations where traditional regional adversaries have highly dissimilar capabilities.

VII. OBSERVATIONS, CONCLUSIONS, AND PRELIMINARY RECOMMENDATIONS

In this section we present a number of observations, conclusions, and preliminary recommendations regarding domestic implementation of the proposed CWC. The comprehensive treaty is still being negotiated. Not only is there interest in the treaty, but also considerable support for a rigorous nonproliferation system to slow the spread and use of chemical weapons, perhaps as a temporary stopgap until a comprehensive and effectively verifiable treaty is completed. The major powers agree on the need to prevent the flow of chemical-weapons technology, know how, and materials toward military applications, particularly among developing nations. The United States is a member of the Australia Group, an informal association of Western countries dedicated to regulating such exports. Recent reports that Iraq, Iran, and Libya acquired chemical-weapons capability through international channels highlight the importance of effective export controls, and both former President Reagan and President Bush have addressed the problem of chemical weapons, its spread to more than 20 nations, and the need to prevent diversion. Both the U.S. Draft and the Rolling Text lack provisions for monitoring and controlling international transfers of chemicals, equipment, and know-how for CW production. Whether such provisions will ultimately be written into the convention, or whether a separate system of export controls will be maintained, has not yet been determined. Such a system may be required even after the CWC enters into force, to verify that treaty signatories are not assisting nonsignatories to acquire a CW offensive capability.

QUANTITATIVE ASPECTS

The quantitative dimensions of the Chemical Weapons Convention have not yet been accurately determined. The Soviets have announced stocks of 50,000 metric tons of toxic chemical agents but have not declared the sites of the stocks. Intelligence sources suggest this is a low estimate. The United States has declared the locations and fractions of its unitary[1] stockpile at each location but has not revealed the

[1]Unitary weapons contain toxic CW agents in a form that is premixed and ready for dispersal. Binary weapons contain two nontoxic chemicals in separate containers, which

total size of its arsenal, and most other likely possessors have been silent or have denied the existence of CW stockpiles. U.S. planned stocks of binary weapons are retaliatory in purpose, and are expected to be limited in number. It seems plausible to estimate that world stocks are on the order of 10^5 metric tons, located at perhaps 10^2 sites. We speculate that between 10 and 30 private facilities in the United States produce about 10^6 lb of Schedule II substances and the number of such plants worldwide may be in the 10^2 range. The number of facilities capable of producing even small quantities of treaty-banned or regulated chemicals may be on the order of 10^3 in the United States and ten times this quantity worldwide. The concept of a militarily significant quantity, while highly scenario dependent, is presumed to be in the 10^4 ton range for all-out use against NATO in a Central Region war and 10^2 to 10^3 tons for use against a specific set of NATO targets that may be particularly vulnerable to CW in terms of degraded operational effectiveness. The quantities that could be significant in regional conflicts could be an order of magnitude less, and unprepared civilians or troops could even be vulnerable to such primitive toxic chemicals as phosgene and hydrogen cyanide.

Given the large uncertainties in the scope of the treaty, it is far too early to estimate the size of the secretariat and its costs of operation, but using the IAEA as a guide, several hundred inspectors and costs of perhaps \$50 to \$100 $\times$ 10^6/year after the first few years may be a proper order of magnitude. Since the costs of compliance will depend on the final terms of the treaty and the U.S. program for implementing it, it is premature to attempt to estimate the private and public costs of U.S. compliance.

INDUSTRY TAKES AN ACTIVE ROLE

A number of important policy issues remain to be negotiated (among industry, the U.S. government, the Conference on Disarmament, and the Soviet Union), and a number of important details must be worked out with regard to both nonproliferation and a comprehensive treaty. Because the precise configuration of the treaty and its protocols are likely to change, we have couched our discussion in conceptual rather than detailed terms, hoping in this way to avoid premature obsolescence as the negotiations evolve. The full repercussions of the U.S. position with regard to inspecting the Libyan CW facility have not yet

mix and react to form toxic CW only when the weapon is released. The Big Eye bomb and CW projectiles for Multiple Launch Rocket Systems and 155-mm guns are weapons of the latter type.

been felt at treaty negotiations. We may expect, however, proposals for a more rigorous form of short-notice challenge OSI, perhaps involving continuous on-site surveillance or instrument monitoring.

The chemical industry is now entering into serious policy and technical discussions and seems less compliant and more critical than it has in the past. Industry's concerns have shifted from its additional reporting burdens to the ramifications of challenge OSI; it seems most preoccupied with the effectiveness and intrusiveness of routine OSI of Schedule II facilities, the only provision in the Rolling Text and U.S. Draft that would routinely expose commercial facilities to OSI. The appropriate level of intrusiveness and detail is both a political and technical matter. As we remark later in this section, industry may be preparing to challenge the utility of routine OSI, a treaty element which until recently was generally agreed to be the linchpin for surveillance of the world's chemical industry.

The U.S. and other nations' experience with the only other analogous treaty, the IAEA safeguards agreement, suggests that the actual practice of treaty verification may be far less intrusive and adversarial than formal treaty documents would suggest. However, IAEA does not act as an international police force, choosing rather to serve the smaller role of confirming the accuracy of material accounting data provided by signatories. Thus, IAEA's value as a model for the proposed CWC organization is limited, given the emerging consensus that CW verification may need to be far more rigorous to provide effective verification and it would be unrealistic to push the analogy very far. Also, IAEA never attempted to roll back the number of nuclear weapon states, whereas the goal of CWC would ultimately be to reduce the number of CW capability states from the present 20 to zero. Nevertheless, IAEA's experience offers some specific lessons.

The world (and the chemical industry) has learned a great deal about treaty negotiations (both among government agencies and between the U.S. government and other nations) from the recent spotlight on INF, but those negotiations did not include industry as an important player. To a great extent, U.S. industry, which could have been exposed to the threat of INF "anywhere, anytime" short notice inspections, benefited from the evolution of the zero-zero option and concern over the compromise of national security secrets. Short notice inspections are restricted to a declared set of facilities, including only two contractor-operated sites.

The emergence of the chemical industry as an informal but important participant in CWC negotiations has increased the complexity and sensitivity of the negotiating process. Although a general consensus seems to be growing among the representatives of the large U.S.

chemical firms that are involved in government-industry discussions, there is no assurance that others in industry will not raise important objections during the ratification process. The Senate may respond to these objections, and the House will play a role in the implementation process if new authorizing legislation is required, and if funds for implementing the treaty cannot be obtained by inter- or intra-agency transfers. Even were the treaty to enter into force, the private sector could pose a number of legal obstacles and at least temporarily delay implementation, to the potential embarrassment of the U.S. government. For these reasons, it would be desirable for the government, when it prepares to implement the treaty, to avoid activities and approaches facilitating legal challenge. Suitable legislative preparations need to be made. A statement by Senator Paul Simon (D. Ill) in the *Congressional Record* (S9147, July 8, 1988) is an early indicator of possible ratification difficulties. He suggests that the "U.S. government could be negotiating a treaty that conflicts with our Fourth Amendment right to privacy." The statement was made in the context of introducing a paper from DOE's Argonne National Laboratory dealing with legal issues surrounding warrantless search procedures (Tanzman, 1988).

The industry consensus, although still evolving, includes the following general elements:

- Support for a verification system that is sensitive to industry concerns regarding intellectual property rights.
- Skepticism about the feasibility of achieving an airtight or even effective verification without including surveillance of international traders, brokers, shippers, and others who operate the international distribution network for chemicals and chemical technology.
- Limited concern over the need to comply with additional reporting requirements but major concern over the rigor and scope of inspections and the risks of losing proprietary know-how and trade secrets during routine and challenge OSI.
- Growing interest in alternatives to routine OSI of facilities that produce key precursors.

In addition, an impression we have derived from discussions with smaller firms who do not regularly participate in consultations with government is that they are concerned about the additional burdens of complying with treaty requirements, particularly routine inspections that could be proportionally far more onerous for small firms than for large ones. A CEO of a small manufacturing firm suggested that the

firm's entire staff would probably be involved in preparing for and hosting inspections and that production would cease during the inspection period. The top managers of large U.S. chemical companies are becoming aware of the potential ramifications of the CWC,[2] but a number of the small firms we have contacted seemed either unaware of the treaty's possible impact or viewed it as another layer of government regulation. Until recently, U.S. firms seemed far more willing to undergo rigorous OSI than their Japanese or European counterparts or representatives of such nations as Argentina, Pakistan, and India who have traditionally opposed all international attempts at nuclear nonproliferation. The urgency of the need for effective nonproliferation and chemical arms control, as currently expressed by world political leaders, could encourage greater cooperation by world industry.

THE CHEMICAL INDUSTRY, THE GENEVA PROTOCOL, AND THE CWC

The current situation with regard to the U.S. chemical industry and the proposed CWC contrasts with the period following the First World War when the Geneva Protocol was under consideration. At that time, chemical technology was closely linked to weaponry by the industry, the public, and the government. U.S. chemical firms had lobbied to gain access to German dye and chemical technology through amendments to the Treaty of Versailles, and although the attempt to use the treaty to acquire German trade secrets and to eliminate German competition was not entirely successful, restrictions were placed on the German chemical industry.

The perceived linkage between chemical technology and poison gas or munition production was employed by industry officials to support high protective tariffs and reduced imports of dyes and chemicals. Their argument was that the strategic value of the chemical industry, should it need to be mobilized in time of national emergency to produce weapons, required that it be encouraged to develop the know-how and capacity that could be converted on short notice to produce weapons for the government. This same argument was used by President Wilson in support of high tariffs on chemical imports. In 1925 and 1926, U.S. chemical firms who had not been consulted during the drafting opposed the Geneva Protocol, and a number of trade and

[2]CMA President R. A. Roland issued a press release on April 2, 1988, that called "for a strong effective international treaty to ban the use of chemical weapons," and announced an ongoing series of consultations with other international industry groups to help bring about the treaty.

professional organizations, including the American Chemical Society, opposed the ratification of the Protocol. These activities were responsible, in part, for the Senate's rejection of the Protocol in 1926. (It was eventually ratified in 1975.)

The situation today is strikingly different. Federal agencies are heavily involved in chemical regulation. The mainstream legitimate chemical industry has no business interests in chemical weapons, is not involved in their production, and wishes to eliminate any perceived connection between industry and agent production that could influence its public image. The principal industry trade association, the Chemical Manufacturers Association (CMA), has formed the Chemical Weapons Work Group (formerly the Phosphorous Panel) to develop and submit comments to U.S. government agencies on questions that arise during the drafting of the CWC. In 1987, Dr. L. Zeftel of DuPont summarized the position of the CMA by stating that "the American chemical industry is totally supportive of the international efforts to establish a treaty that will ban the production and use of chemical weapons systems" (Zeftel, 1987). He also suggested that the industry has a dual role with regard to assisting the negotiators:

> On the one hand, technically, we should identify those areas where existing means of verification can be used and those areas where considerable development work is required to assure a meaningful verification system. On the other hand, we have a responsibility to the chemical industry itself, which is to ensure that the controls and their implementation will have minimal detrimental impact on the chemical industry. (Ibid.)

We can paraphrase Zeftel's remarks and those of others in industry to summarize the general position of many in the U.S. chemical industry:

The industry supports the treaty, accepts the notion that reporting and some forms of on-site verification will be necessary, and is willing to endure reasonable but potentially intrusive reporting and monitoring protocols if the verification process is both realistic and effective. The industry would ask that the treaty be cost-effective, that the knowledge gained from their submitting of pre-inspection reports and undergoing on-site inspections and inventory audits should justify the combined efforts of the treaty organization, the nation, and the plant operator. Most importantly, industry asks that the risks of losing proprietary material of all kinds be minimized.

The difficulties involved in translating this position into practical policies are outlined below.

ROUTINE INSPECTIONS

Both the U.S. Draft and the Rolling Text call for routine or systematic inspections of declared facilities that produce key precursors—Schedule II chemicals that are but one or a few reaction steps removed from actual chemical warfare agents. Although no precise count has been taken, estimates suggest that on the order of 100 of these facilities may operate worldwide and less than 30 may operate in the United States (see App. B). The true number of facilities that produce or process these chemicals is difficult to estimate, even in the United States, because traders and brokers who list themselves as suppliers in directories and buyer's guides may not actually produce or even take possession of the material they sell. A rigorous and formal effort by the U.S. government will be necessary to identify the entire universe of Schedule II facilities and their pertinent characteristics.

Objectives of Routine OSI

The specific objectives of routine inspections would be to confirm material accounting data provided by signatories for facilities under their jurisdiction, to verify that key precursors are not being diverted to illicit use, and to help monitor the international (and intranational) transfer of chemicals which, despite their legitimate role in commerce, have significant potential for producing treaty-limited material. Monitoring the international economy and transfer of key precursors seems desirable because nations with limited indigenous chemical production facilities could view the import of materials as an efficient route to build clandestine chemical warfare arsenals. Even if production facilities are subject to random thorough routine inspections (an example is given below), it may also be necessary to consider monitoring chemical distribution and processing pathways that could be used to divert chemicals from declared purposes. Media reports on the role of international brokers, traders, and transportation firms in supplying materials and technology to build chemical arsenals underscore the importance of the distribution system.

If only tens or hundreds of tons of key precursors can result in militarily significant quantities of toxic chemical agents, the task of monitoring national and international distribution systems with a high probability of detecting diversion becomes difficult. Nevertheless, routine OSI may need to be supplemented by attempts to monitor potential diversion pathways since the critical role these pathways play in proliferation has already been demonstrated.

Export Controls

Despite limitations in their apparent effectiveness, routine inspections can play an important symbolic role by focusing national and international attention on key precursor chemicals and the facilities that produce them. When combined with rigorously applied export controls, they could help to monitor and regulate international transfers by controlling or confirming proximal destinations of chemicals shipped from declared facilities. Even if key precursor plants were not subject to OSI, export controls could deter plant operators, brokers, traders, processors, and distributors from diverting material to illicit channels if a country's policy was to rigorously enforce such controls. However, a treaty signatory wishing to encourage or abet others (including nations, insurgents, or terrorist groups) to acquire precursors could easily facilitate illicit international transfers. Unilateral export controls alone would be ineffectual, but the likelihood of routine OSI might add a measure of deterrence. Further, under certain conditions, OSI could illuminate significant transfers within a state, and in this way would increase the difficulty and costs of circumvention. If, as industry suggests, the monitoring of distribution networks is essential for effective verification, a more comprehensive verification system may be necessary than is currently envisioned—one that combines strict export controls, routine OSI, and monitoring of the distribution system. States with developed technical, industrial, transportation, and military infrastructures can circumvent the treaty or assist others in circumvention with little risk of detection. Furthermore, it would be difficult to implement a program that with high probability could detect quantities potentially significant in regional conflicts. Nevertheless, a combined verification regime would not only increase the costs of diversion but could also improve the chances of detecting and deterring noncompliance in less developed countries.

Along these lines, the CMA is formulating a draft provision for consideration by treaty negotiators to control, report, and monitor international shipments of Schedule I, II, and III chemicals and pertinent technology. The proposal is likely to include provisions for coordinating national and international programs of export and import controls and inspections of import and export documents, storage and transfer points, and transport modalities.

In addition to monitoring and regulating international transfer of CWC Schedule I, II, and III chemicals which are agents, precursors, or otherwise uniquely related to CW production, it may be desirable to broaden the list of controlled chemicals to include those which are essential not because of toxicity or unique structure but because their

acquisition would facilitate CW manufacture by less developed countries. Thus, a nation with a limited pharmaceutical or chemical industry would have no need for large quantities of thionyl chloride, a chlorinating agent with broad commercial applications, or sodium fluoride, a fluorinating agent added to toothpaste for cavity prevention. These and similar chemicals are included in the Australia Group core and warning lists. This is analogous to the two classes of chemicals that are controlled under the 1988 Chemical Diversion and Trafficking Act that regulates the sales, imports, and exports of material and equipment that could be used to produce cocaine and other illicit drugs. One class consists of drug precursors, and the other class consists of essential chemicals such as solvents or catalysts which are used in chemical processing. The threshold quantities for triggering regulation are set much higher for the solvent/catalyst class than for the precursors.

A Strawman Protocol for Routine OSI

To grasp the potential dimensions of routine on-site inspection, we outline a protocol that we have adapted from several sources, including a British proposal, CD/575, and remarks made by a representative of the Chemical Manufacturers Association (quoted in the *Arms Control Reporter*, 1988 Chronology, 704.B.266). This protocol, designated a strawman because of its extreme stringency, permits a highly detailed and intrusive inspection that spans the entire production process from feedstock delivery to shipping dock, storage, and the first steps in distribution. No area within a facility would be denied to inspectors, and the inspection team would be permitted to thoroughly audit all documents, including manifests, customer lists, and shipping destinations. Perhaps the only inspection element missing from this protocol is the right to randomly interview plant personnel, a right that if granted could lead to charged international disputes. From the perspective of industry, the protocol would be considered unnecessarily intrusive and would offer great opportunity for industrial espionage and illicit technology transfer.

In the strawman protocol, the inspection team is granted an entry visa in a timely fashion and arrives at the declared facility within a specified period of time. Before arriving at the site, the team studies file data about the facility and requests flow and process diagrams with updates about changes or new developments. Facility data are available on-site, including information on how feedstock chemicals are brought into the plant and stored; feedlines and their contents; reactor vessels and related stirrers, condensers, and cooling apparatus that may be seen during inspection; relevant plant equipment for physical separation including distilling, filtering, centrifuging, and fractionating components; destination of

all inlet and outlet lines and a description of their contents; how products are stored on-site and transported from the facility; how reactions and processes are controlled; stages and specific locations where measurements and samples for quality control are or could be made; the nature of the analytic methods that are employed and their estimated precision; and a description of plant records with emphasis on feed chemicals, end products, and destinations.

The inspection tour would include the loading area where feed chemicals are stored; the area where reactants are prepared for addition to the reactors; all feedlines, valves, flow meters, gauges, etc. that appear relevant; the exterior of reaction vessels and related equipment; the lines from the reactor leading to storage or on-stream use; and process control equipment. A number of sampling points might be used to sample the contents of input feed and final product lines, storage tanks, tank trucks, tank cars, drums, and reactor vessels. Air, water, and wipe samples would be obtained in production and storage areas. Samples would be assayed at the site (if possible) using the analytical facilities of the host facilities. Multiple samples would be taken to assure that data are consistent and representative and also to protect the host facilities in the event of dispute. If suitable analytical instrumentation is not available for on-site measurement and comparison with known control samples, appropriately packed samples would be sent to an agreed on off-site laboratory for precise analysis. Data for material balance accounting should be gathered to confirm the absence of significant discrepancies. Samples, possibly hazardous, would need to be packaged for transit, and suitable procedures for the shipping of dangerous or potentially dangerous substances need to be implemented. Manifests and customer and supplier lists could be scrutinized. If deemed necessary, the inspection team can request that components such as valves, seals, and pumps be dismantled for sampling.[3]

Potential Risks

Industry representatives often assert that comprehensive inspections of chemical plants could result in losses of trade secrets, know-how, and proprietary material that plant operators may deem confidential. For example, measurements of samples drawn from a reactor could

[3]Sixteen nations, including the United States and the Soviet Union, had already performed mock inspections of chemical plants as of February 1989 (reported by Ember on p. 24 of the March 6, 1989 issue of *Chemical and Engineering News*). The U.S. inspection took place at a facility operated by Akzo Chemicals, Inc., in West Virginia, and is described in detail in a publication of the Conference on Disarmament, CD/922, June 22, 1989. The plant produces Schedule II chemicals that have fire retardant applications from a Schedule III chemical, trimethyl phosphate.

reveal the composition and properties of unique catalysts; flow and process information gathered from diagrams, charts, visual observation, and measurements could reveal proprietary process and control data, or even whether a process is batch or continuous; studying manifests and examining feedstock containers and labels could reveal confidential information about raw materials and suppliers; auditing customer lists and shipping destinations could provide competitive advantage in marketing; and data about capacity and product mix could be used in business and investment decisions by competitors.

Potential losses of this nature are hypothetically possible. Whether losses of significant value can occur under realistic conditions depends on a number of factors: the rigor of the inspection; an inspector's knowledge, experience, and intent to perform acts of industrial espionage; a potential client for proprietary data who can successfully use the data; and most importantly, the existence of a body of confidential material that if revealed could lead to substantial economic loss. The nature and value of confidential proprietary material will depend on the specifics of the industry or sector within an industry. Thus, emerging and highly competitive leading edge industries such as biotechnology or advanced materials are more likely to be at significant risk than mature static sectors that rely on old plant and standard technology. However, given the highly proprietary nature of the chemical industry, plants operating with mature technology could also suffer economic loss. A skilled inspector could detect slight differences in the composition or purity of feed chemicals, or the precise order in which chemicals are added, examples of proprietary know-how that may result in small but significant cost advantages.

Because specific data to formulate a proper risk assessment are not yet available, it would be useful if representatives of the sectors of the chemical industry producing Schedule II chemicals were encouraged to provide a more precise assessment, perhaps confidential, of the sensitivity of the affected facilities to various forms of industrial espionage. Such an assessment would be difficult without the cooperation of plant operators.

No entirely satisfactory method has been developed for preventing the loss of confidentiality by acts of an international treaty organization. The history of the IAEA Safeguards program (see Sec. VI) reinforces concern regarding the likelihood of such loss. However, if economic loss were to occur, U.S. firms could in theory seek damages under the Tucker Act and Fifth Amendment guarantees against the taking of private property for public use without just compensation. Thus, OSI of private facilities raises Fourth and Fifth Amendment issues that could require resolution.

Industry's Skepticism

Not only is industry concerned about risks, it is also skeptical about the value of routine OSI of declared commercial facilities. Kyle Olson, a CMA official, summarized the U.S. chemical industry's belief (Olson, 1988) "that the likelihood of detecting violations by examining declared plants is very low," an opinion likely to be held by European and Japanese industry representatives as well. Facilities that produce key precursors are generally located in developed nations with substantial commercial, technical, distribution, and military infrastructures. Routine OSI would not be as effective in such circumstances as in less developed countries where the expertise and technology for circumvention are thin and the pathways for diverting material are few.[4] Since the expected international flow of precursors would be from developed to less developed countries, routine OSI alone may be inadequate to detect and deter interregional diversion and additional steps of controls and monitoring of the worldwide distribution network may be needed. If developing nations house Schedule II facilities, routine OSI could deter South-South or perhaps even intranational diversion. However, the relative dearth of such facilities among developing or less developed nations appears to confirm industry's skepticism about the utility of routine OSI as the principal instrument for monitoring the world's chemical producers.

Alternatives to routine OSI of commercial facilities suggested by the British and the West Germans involve ad hoc inspections of undeclared facilities, either on a random or challenge basis (Ember, 1988), and RAND is also exploring a variant involving short notice inspection of defined sites that could in certain instances eliminate the requirement for routine OSI.

Although an external inspection involving routine waste stream and effluent sampling and monitoring of the environment external to a plant could be a useful means of surveillance and an alternative to entering a site that is suspected of producing a banned class of chemicals, its utility seems limited as a substitute for routine OSI of facilities that produce Schedule II chemicals. Such facilities are permitted to produce certain treaty-related chemicals, but would be prohibited from diverting such chemicals to illicit use. Thus, discovery of traces of a Schedule II chemical in effluent is not likely to support an accusation of a treaty violation, and there would be little reason to expect external inspection to be effective in deterring diversion. However, an external

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[4]Less developed nations have used various crude methods to hamper the conduct of IAEA inspections, as described in Sec. VI. Technical sophistication may not be a requisite for successful cheating.

inspection of exit lines and shipping containers could help in the surveillance, monitoring, and confirming of destinations as well as providing a symbolic presence. On balance, external inspections would be useful that can confirm the destination of chemicals or detect whether facilities are producing treaty-limited material. The technical feasibility of such inspections remains to be determined, as is their relative value compared to a detailed internal inspection such as the strawman protocol described above.

If a sufficiently high detection probability is not likely to be achieved, what are the other benefits of a rigorous routine OSI? Although useful in evaluating mass balance procedures and the accuracy of instrumentation, it does not seem helpful in verifying production or capacity data provided by a signatory or even whether more material is produced than is accounted for in plant documents. Also, since the sites are already known to produce key precursors, the monitoring and sampling of declared facilities for chemicals which are regulated but not prohibited are germane only if they indicate diversion to CW production pathways. Unless a plant that produces legitimate precursors is also used to produce illicit chemicals, the ability to perform a comprehensive audit trail as a means of monitoring the distribution network for key precursors may be the major benefit of routine OSI. Additionally, the symbolic benefit noted earlier could demonstrate that portions of a possible CW production network are under strict international surveillance. Unfortunately, it would be difficult to determine whether the confidence engendered by such surveillance would be truly merited.

Batch, Continuous, and Multi-Purpose Plants

Industry has expressed reservations about the ability to verify nonproduction and nondiversion in batch process plants where a number of different products can be produced as well as about the measurement of capacity in plants of different types—continuous, batch, dedicated, and multi-purpose. Industry may also be concerned about the broadening of the universe of facilities subject to CWC jurisdiction to include multi-purpose facilities that have the "potential" to produce treaty-related substances. If "potential" production facilities are included in the treaty, threshold quantities could be large enough to eliminate the many batch process specialty manufacturers who might be capable of producing only small quantities of material.

We agree that a strict verification regime might be needed to deter the conversion of such plants to the production of treaty-limited materials, but cannot assess the incremental improvement associated with

such a regime. We must remark, however, that a comprehensive approach that greatly broadened the universe of potentially affected facilities and firms could easily become unwieldy in practice. Such facilities, many of them small, could be most suitable for challenge inspection rather than routine procedures, perhaps along the lines of including these sites on an eligibility list for some form of short notice inspection.

MASS BALANCE AS AN AUDITING TOOL

As we indicated in our earlier review of IAEA safeguards, mass balances and material accounting are the basis of the verification system for nuclear material. No practical analogy exists for chemicals. There is little evidence that chemical mass balances as a means of detecting diversion and clarifying anomalies are sufficiently precise in practice to be useful in the verification of CWC reports submitted by chemical facilities. The National Research Council is investigating the practical value of mass balances to estimate the environmental release of substances regulated under the Superfund Amendments and Reauthorization Act (SARA). Mass balances are excluded from SARA until their efficacy has been determined. The chemical industry is, moreover, quite skeptical of its ability to gather sufficiently precise mass balance data to detect the diversion of precursors in quantities of potential military significance, even in modern, well-instrumented, and controlled plants. Mass balance discrepancies of 5 to 10 percent, while high, can occur, and such discrepancies when integrated over a long period of time can lead to uncertainty levels that are of possible military significance.

Unfortunately, and despite the limitations on its ability to detect anomalies, the mass balance approach is one of the few quantitative tools that an inspector may employ that could be used to verify a paper audit. Although the limits of mass balance methods need to be evaluated, we believe that consultation with industry on this question is important and that it is unreasonable for industry to be required to obtain mass balance data beyond its standard operating practice.

WILL THE INDUSTRY OPPOSE RATIFICATION?

Although it is difficult to predict the course of ratification for a treaty that is still being drafted, we cannot envision a recurrence of the 1925–1926 situation in which chemists and the chemical industry vigorously opposed the Senate's ratification of the Geneva Protocol. However, we expect that industry may raise a number of general points

before and during the ratification process, independent of the final terms of the convention. These points are:

- That the U.S. system for implementing the treaty be in practice no more intensive or intrusive than that of other signatories. If the IAEA experience can be used as a guide, considerable leeway may exist from country to country or even facility to facility in the actual implementation of the treaty. If this is the case, industry will need to be assured that the treaty will be implemented in a nondiscriminatory manner, in the sense that U.S. firms, both as a group and individually, will be treated fairly.
- That the additional burden of complying with CWC reports and inspections is proportionally more onerous for small firms than for large ones, and a number of manufacturers, processors, and brokers of treaty-related chemicals are small businesses. As we suggested earlier, the government-industry dialogue concerning the CWC is dominated by large chemical firms, the small firms having neither the resources (money, time, and staff) nor the information to engage in such dialogue. However, if an inspection were imminent, these firms would be statutorily compelled to participate. Therefore, it would not be surprising if small business were to request special, perhaps even compensatory treatment, particularly with regard to the costs of complying with routine or challenge inspection. The setting of minimum thresholds is an approach that could exempt firms with small production capacity.
- That the industry would seek safeguards against the loss of proprietary data. Such safeguards might involve procedures similar to or even stronger than those specified in the implementation rules for the U.S.-IAEA Agreement:
  - Material which is deemed particularly sensitive would not be submitted to the treaty secretariat but would be maintained on the premises of the U.S. treaty agency for viewing by international officials. Facility operators should be consulted during negotiations between the United States and the treaty secretariat on the selection and carrying out of inspections.
  - U.S. government observers should accompany inspection teams if requested by the plant operators.
  - Provisions should exist for designating data as Confidential Business Information in accord with standard government procedures.

Right to Approve Inspectors

A fundamental question that will need to be resolved during treaty negotiations is whether nations or individual facilities will have the right to refuse to accept individual inspectors or entire classes of inspectors, as exists under IAEA safeguards (see App. E). We suggest that both government and industry evaluate the merits of veto rights on individual and classes of inspectors. International agencies have limited enforcement powers to deal with conflicts of interest and security violations and the possibility exists of CWC inspectors or other international staff members using their positions to engage in industrial espionage.

The precise qualifications for and training of inspectors remain to be worked out. If the CWC is to be effectively verified, inspectors and officials who are familiar with Schedules II and III chemicals should have general experience with the requisite chemical process technology at both theoretical and practical levels. The source of such candidates would be the chemical industry itself, and presumably plant operating staff would form the pool of individuals from which the inspectors would be drawn. These positions should not provide entry level jobs for recent university-trained chemical engineers since considerable experience in plant operations will be needed. Also, former military chemical officers would possess qualifications suitable for Schedule I chemicals.

Depending on the personnel retention policies and turnover rates of the international CWC secretariat, inspectors may maintain informal but strong ties with firms in their native countries. The risk of industrial espionage under the guise of treaty verification might make these inspectors unacceptable to certain nations and facilities. There may be reluctance to hire inspectors who are "too" highly qualified for fear of industrial or other espionage, but there should also be a reluctance to hire personnel with little plant experience. From the IAEA experience, it seems that the increasing bureaucratization of the inspection process may minimize the likelihood of confrontation but could also weaken the effectiveness of verification.

From the viewpoint of balancing verification effectiveness and intrusiveness, a veto right on inspectors could markedly weaken the effectiveness of verification. It is plausible to believe that an objective and perhaps even adversarial inspection team is more likely to provide effective verification than is an "approved" inspection team. This issue does not arise in a bilateral treaty like the INF, where an adversarial relationship is expected between the two sides. One intriguing possibility is an inspection regime that includes both bilateral and multilateral

elements, i.e., a subsidiary agreement between the United States and USSR or the Pact and NATO, as well as a main multilateral component. An architecture for this type of verification regime is being considered as part of a related RAND study on challenge OSI.

We believe the IAEA Safeguards program has continued to function because of the confidential and highly diplomatic manner in which the agency conducts its activities and the emphasis, in practice, on cooperating with and even acceding to the wishes of the host country. The IAEA's statute and its agreement with individual signatories permit it, in theory, to be far more intrusive and confrontational than it chooses to be in practice. Certainly the IAEA seeks no larger investigative role. Since there has never been a systematic and open evaluation of IAEA effectiveness, we are not able to judge the effectiveness of this approach in preventing the diversion of nuclear material to illicit uses, or even as a builder of confidence. Although IAEA is not a suitable paradigm for CWC enforcement, there are important lessons to be learned from IAEA's history and its relationships with NPT signatories.

Legislative vs. Administrative Approach

The chemical industry, both individual firms and as an entity, is too experienced and skilled in regulatory matters to permit OSI or new reporting burdens to be imposed without careful review by its legal counsel and consultants. Therefore, any implementation program that omits legal steps could be subject to challenge, injunction, and delay, to the embarrassment of the United States. In the INF case, only the DoD and its contractors are involved, and only declared sites can be inspected. Accordingly, we believe that new authorizing legislation, rather than the amendment of existing regulations, will be needed to implement the chemical treaty. Thus both Houses of Congress are likely to be involved. During the ratification of the U.S.-IAEA Safeguards agreement, the Carter administration had either option, but chose the purely administrative path of amending the NRC regulations that stem from the original 1954 AEC authorization. Had the IAEA agreement been implemented using the legislative approach requested by Senator McClure, much greater congressional involvement in the entire domestic Safeguards program would have ensued as well as a potentially contentious review of the Carter administration's nuclear nonproliferation policy.

The need for new legislation is discussed in a provocative article by Tanzman (1988), who examines the constitutional questions arising from an interpretation of the U.S. Draft's provisions for special or ad hoc OSI as implying the necessity for warrantless searches of private

commercial facilities in the United States by foreign inspectors. Tanzman judges that routine systematic inspections of declared facilities involved in CW-related activities raise no serious Fourth Amendment issues. He speculates that "anywhere, anytime" challenge OSI may pose legal issues that, if not resolved in a timely manner, could place the government at risk of agreeing to a treaty whose provisions could be successfully enjoined by operators of private facilities. In addition to proposing that "anywhere, anytime" OSI be eliminated in favor of remote monitoring, Tanzman suggests several legal approaches that might permit warrantless searches: (a) the possibility that the Fourth Amendment warrant requirement does not apply to searches involving foreign affairs, an issue not yet considered by the Supreme Court, (b) the possibility that undeclared private facilities subject to challenge OSI are considered to be "pervasively regulated," and that the facilities are part of an industry, such as mining, in which the industry "consents" to warrantless inspections as a regulatory cost of doing business, or (c) a full-fledged congressional effort to develop a federal statute "intended to mitigate constitutional conflict between the Fourth Amendment and on-site arms control inspections" by limiting the availability of injunctions to prevent treaty-related inspections. If indemnification then became the only available remedy, the government could simply "buy itself out" of a potentially embarrassing situation. Without judging the merits of Tanzman's arguments, we believe that an approach modeled after the OSHA ex parte warrant procedure developed in response to objections raised by the Supreme Court in *Marshall v. Barlow's, Inc.*[5] would be consistent with the objectives of article X and article XI of the U.S. draft treaty. The U.S. Draft Convention is not yet written in formal treaty language, and further, it does not specify a warrantless inspection. Thus the OSHA approach would satisfy both the letter and spirit of the U.S. proposal. If the OSHA procedure were to be employed, a special federal magistrate, possibly on call, would be notified when an international inspection team announces its plans to inspect a private facility. The magistrate would then quickly review the request without notifying site operators, to verify that appropriate procedures in accord with federal law, the ratified treaty, and its protocols have been followed. This approach seems to be an effective way to proceed, initially, either in lieu of a warrantless procedure, or until legislative support is developed for warrantless searches for arms control verification.[6]

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[5]*Marshall v. Barlow's, Inc.*, 436 U.S. 307(1978).

[6]Each signatory would develop procedures that are consistent with its own constitutional tradition. The procedure described here applies only to the United States.

A new or existing institution or agency needs to be authorized and funded to implement the treaty. This agency should be charged with responsibility for U.S. firm compliance with the treaty similar to NRC's role in the nuclear industry's complying with the U.S.-IAEA Safeguards agreement. As we discuss below, the newly formed On-site Inspection Agency's mission could be extended to include CWC implementation. Further, the relationships and responsibilities need to be clarified among the various agencies with interests in CW arms control. Once an agency is authorized to implement the terms of the treaty, the powers of the agency delineated, and the enforcement provisions specified, the agency will prepare a set of administrative regulations using the traditional methods of publication in the *Federal Register*, solicitation of responses, publication of the final role, and ultimately, the codification of regulations in the *Code of Federal Regulations*. After these regulatory steps have taken place, the agency will coordinate all U.S. activities that are necessary to comply with the terms of the CWC including the collection of required data, submission of reports to the international secretariat, and negotiations with the International CWC Organization concerning inspections in U.S. government and private facilities. In essence, the agency would serve as a buffer between private U.S. firms and the international CWC Organization. The agency would of course be involved in all the other aspects of the CWC that bear on the national security sector: the declaration, inspection, and destruction of CW-related military facilities.

A BILATERAL AGREEMENT

It is possible that U.S. participation in a multilateral CWC will be preceded by a bilateral agreement with the Soviets using a memorandum of understanding (MOU). This instrument is expected to require a domestic system for reporting, and for implementing OSI of both military and commercial facilities. If the MOU were signed by the executive authority, it would then constitute an executive agreement and would fall under the Case-Zablocki Act, which requires that the text be transmitted to Congress within 60 days. If no prior authorization existed, Congress would then need to authorize a new or existing agency to implement the terms of the agreement and appropriate funds for its functioning. The On-Site Inspection Agency (OSIA) could, depending on the terms of its authorization, implement the terms of the MOU as well as the CW treaty.

The On-Site Inspection Agency as a Candidate for CWC Implementation

The agency that seems to be the most suitable candidate for CWC domestic implementation responsibility is the newly formed OSIA. The Under Secretary of Defense for Acquisition is responsible for ensuring DoD compliance with arms control agreements. The OSIA was established within Acquisition as part of the implementation machinery required for U.S. compliance with the INF treaty. The mission of the OSIA is to recruit, equip, and manage U.S. teams inspecting treaty-related facilities in the USSR and Eastern Europe and to coordinate all activities associated with the conduct of inspections by the Soviet Union on U.S. territory or at U.S. controlled facilities in Europe. The total costs for implementing the INF treaty, including the transportation and destruction of treaty-limited items are not known precisely but are probably in the hundred million dollar per annum range, for fiscal year 1988 and 1989. The actual OSIA portion of these costs were $20 million in 1988 (due to a late start) and are estimated to be $50 million in 1989. We note that salaries for military personnel may not be reflected in these cost estimates.

The OSIA director is drawn from the Defense Department and its associate directors are from ACDA, State Department, and FBI. The agency is required to coordinate with all interested executive departments and agencies. The OSIA was initiated by executive action rather than by legislative authorization. Two classified documents—a Defense Department Directive and a National Security Decision Directive (NSDD 296)—provided the initial basis for the formation of the agency, and OSIA's startup costs were obtained by inter-agency transfer of funds. Senator Jesse Helms (R,NC), an outspoken critic of the INF and ranking minority member of the Senate Foreign Relations Committee, raised a number of questions pertaining to the legitimacy of OSIA's existence and funding in the absence of specific congressional authorization and appropriations. It is likely that an attempt at legislative authorization of OSIA at the time of its inception could have led to more extensive congressional oversight over the formation and organization of the agency.

Given that OSIA already has responsibility for coordinating U.S. activities associated with INF on-site inspections in the United States and abroad and possesses both exprrience and an infrastructure for implementing arms control inspections, it seems to be the most suitable agency to implement other future arms control agreements, including START as well as the CWC. The CWC role will require a considerable ability to acquire data from government agencies and

private firms, organize the data for submission to the CWC secretariat, negotiate with the secretariat regarding on-site inspections in the United States, assist U.S. firms in complying with treaty requirements, and escort CWC international inspectors as they visit both declared and undeclared U.S. facilities. In addition, the agency should coordinate with the Services and other DoD agencies regarding the various U.S. declarations of CW-related activities, sites, and chemicals required for treaty compliance, coordinate baseline and closeout inspections of military facilities in a manner similar to its role in INF, and escort international teams during systematic inspections before, during, and after the destruction of items prohibited by the treaty.

Our recommendations are tentative regarding OSIA's role in training inspectors for participation in the international secretariat. Since the OSIA generally would not perform inspections abroad unless they are part of a special bilateral agreement, as for example might result from an MOU between the United States and the Soviet Union, the agency may not possess any special ability to select or train inspectors for participation in the international secretariat.

It may be useful, however, for U.S. inspectors applying for positions with the international secretariat to be drawn from OSIA staff who have been involved in the domestic implementation program. The converse is also true. Former treaty inspectors would be excellent candidates for a small U.S. treaty implementation team that would be housed within the OSIA.

Small Independent Team

To assure that reporting requirements are properly met, we suggest that a small dedicated organization of highly specialized experts be formed, composed in part of technical staff familiar with the classes of chemicals listed in the Rolling Text. Such experts might be drawn from the pool of former chemical officers and chemical plant operating staff who have both theoretical and practical experience in plant operation, as well as persons who have served in the international secretariat. It is important that the team not develop a regulatory style, but view its principal responsibility as enabling the United States to comply with the terms of the CWC by gathering, processing, and transmitting the required data, facilitating and observing inspections, and generally acting as a technical conduit between the international secretariat and U.S. facilities. The team should be encouraged to interact with industry in the gathering of information for processing into treaty required form and transmitting in accordance with treaty requirements.

To blunt or avoid potential legal challenges of OSI of chemical plants, the OSIA or other agency responsible for implementing CWC should be formally authorized by Congress before the first set of U.S. inspections. If the first CWC inspections of private facilities are coordinated in advance with facilities' operators, the likelihood of legal challenge is small, and the requirement for prior congressional authorization becomes less urgent. Over time, such an authorization would be essential to minimize delays that might be contrary to U.S. interests.

ROLE OF THE EPA

From discussions with a number of chemical industry executives, we are led to the following remarks regarding the role of the Environmental Protection Agency or other domestic regulatory agencies in the treaty:

Industry should be assured that data gathered for the purpose of treaty compliance should not be made available without judicial review to other domestic regulatory agencies such as EPA and OSHA. It should also be stressed that the U.S. agency responsible for implementation is not a regulatory agency in the usual sense since the treaty's objectives fall outside of the domestic regulatory rubric. The agency's role will be to gather information, process it, and ultimately transmit it via the U.S. Mission to the CWC secretariat. Insofar as Schedule II and Schedule III chemicals are concerned, the agency will assist U.S. firms that are subject to routine challenge inspections, and will assure compliance in an efficient cost-effective way.

The statutory mechanisms for collecting data pertaining to the chemical industry are not suitable for preparing the reports and declarations required by the CWC. The reporting and data collection system operating under TSCA, FIFRA, SARA, and other statutes is too fragmented, incomplete, and fraught with potential errors to be reliable. Although some of the data needed for treaty compliance are collected incidently for other purposes, the data are not organized in a way which permits appropriate linkage and accessibility, and quality control of regulatory data is a traditional concern.

Although EPA databases may be used for order of magnitude estimation, we believe that new rather than existing data should be used. This would demonstrate that the treaty reporting requirements are distinct from traditional regulatory procedures. Otherwise, the chemical industry's occasional adversarial relationship with EPA and the spotty record of industry-EPA cooperation has the potential to damage the domestic implementation program from the start.

We have found that industry representatives often espouse the notion that virtually all treaty compliance data required from private facilities are contained within EPA or other regulatory databases. These same representatives also recognize the limitations of the databases and the enormous problems in using existing data reports to gather treaty compliance data. The highly specialized nature of treaty-related chemicals, and the fact that many are not widely manufactured, processed, or sold in commerce, make it unlikely that there would be a great deal of redundancy in reporting. Our own experience in using existing databases to explore specific regulatory niches and data for a number of Schedule II chemicals suggests that the risk of redundancy is less than the benefits of using a highly focused information gathering approach that concentrates on the precise firms, facilities, chemicals, and other data that are required.

This information, we strongly believe, should be gathered through the use of highly specific (and restricted) reporting forms that request only those data that are mandated in the treaty. The chemical industry vigorously opposes the idea of comprehensive reporting rules and forms such as the Comprehensive Assessment Information Rule (CAIR). We are convinced that any attempt to gather more and different types of data than are strictly necessary would promote an unnecessary and ultimately counterproductive adversarial relation between industry and the U.S. implementation team. Members of the team would also engage in the (inevitable) negotiations between the United States and the International Treaty Agency. We recommend that plant operators be encouraged to play an advisory role in these negotiations, similar to the role played by nuclear facility operators in preparing facilities attachments to define IAEA safeguards activities for a specific plant.

CONCLUSIONS

As of July 1989, there is considerable interest in controlling the international spread of chemical weapons. Revelations about the complicity of U.S., Japanese, German, Indian, and West European firms in assisting Libya, Iran, and Iraq to acquire CW have heightened awareness of the proliferation issue. Whether such awareness translates into accelerating the CWC negotiating process to achieve a comprehensive ban and, ultimately, a world without chemical weapons remains to be seen. Furthermore, the relationship between unilateral, bilateral, multilateral, and international CW nonproliferation regimes and the CWC has not been defined. Despite uncertainties on the precise nature of the reporting and verification provisions of the CWC that will evolve

during the negotiating process, our findings generally support the judgment that a feasible domestic system can be developed to comply with the terms of the treaty. The cost-effectiveness and feasibility of such a system will improve if attention is paid to the points we have raised. The development of an effective program to achieve the goals of the U.S. Draft and the Rolling Text will be a difficult and complex process, but one that does not face insurmountable obstacles. There are no major legal barriers, we judge, to the establishment of an OSI system, provided that the system is in compliance with pertinent U.S. statutes. The role of short-notice challenge OSI of undeclared sites is undergoing considerable debate within the government and elsewhere and it is likely that some form of short-notice or challenge OSI of virtually all "relevant" facilities will be included in the final draft. Industry seems to support the idea of challenge OSI and perhaps ad hoc OSI as a substitute for routine inspections. From the perspective of effective verification, it seems desirable that the chemical industry and its facilities be subject to systematic and/or challenge OSI, that reporting requirements to verify the nondiversion of materials and technology to illicit use be enforced, that rigorous export controls be applied, and that the international distribution system for chemicals be monitored.

If the chemical industry continues to play an important role in the coordinating process and its counsel is reflected in the U.S. position, if executives of small and large firms are made aware of the ramifications of the treaty, and if the special problems and needs of smaller firms are considered, then no major roadblocks in the formulation and acceptance of a domestic implementation system are expected. This could change if treaty negotiators try to broaden the range of activities encompassed by the treaty to include the thousands of small batch-process specialty manufacturers who are capable of, but do not produce, treaty-related materials, or if the domestic implementation procedures are perceived as yet another layer of burdensome federal regulation.

From the perspective of U.S. industry, growing sensitivity to the spectre of poison gas has convinced many that the character of any eventual CW treaty should stand or fall on its humanitarian merits and not on the burdens it may impose on industry. These burdens, industry contends, should be commensurate with the humanitarian, political, and national security benefits of the treaty's verification provisions. Moreover, as industry assumes an even more prominent advisory role in the negotiating process, it is reemphasized that the U.S. goal is treaty implementation that balances effectiveness, equity, and efficiency. To achieve this goal, it may be necessary to implement provisions that could be onerous, intrusive, or even unwieldy in the United States. Nevertheless, these provisions could still deter cheating in an international context. In this way they would serve the national interest.

Appendix A

IDENTIFICATION OF CW TREATY CHEMICALS

This appendix presents information on the chemicals specified under the CW draft treaty. We first describe and list these chemicals and then examine the routine reporting and inspection requirements on each party to the treaty.

CW TREATY CHEMICALS

There are three sets of chemicals that would be affected under a CW treaty agreement. The first set—called Schedule A chemicals under the U.S. draft treaty—are "super-toxic lethal chemicals, which have been stockpiled as chemical weapons or which pose particular risks of stockpiling" (CD/500, 1984). The second set of chemicals—Schedule B chemicals—are "chemicals which are produced in large quantities for permitted purposes but which pose a particular risk of diversion to chemical weapons purposes" (CD/500, 1984). The third set of chemicals—Schedule C chemicals—are "chemicals whose production for permitted purposes should be subject to systematic international on-site verification, including key precursors" (CD/500, 1984). The Rolling Text suggests that a fourth set, super-toxic lethal chemicals that are not associated with chemical weapns, be considered for inclusion in treaty reporting requirements.

Table A.1 lists Schedule A type chemicals from the U.S. draft treaty and the Rolling Text. Tables A.2 and A.3 list the Schedule B and Schedule C chemicals from the same two sources.

Note that in Table A.1, the chemicals to be listed in the Rolling Text are generic, whereas those in the U.S. draft treaty are specific. In comparing Tables A.2 and A.3, we observe that thiodiglycol[1] is a Schedule B chemical under the U.S. draft treaty and may be a Schedule C chemical under the Rolling Text. The U.S. draft treaty includes pinacolyl alcohol under both Schedule A and Schedule C. In Tables A.2 and A.3, the Rolling Text specifies more chemicals than does the draft treaty.

[1]Thiodiglycol has recently gained attention because a U.S. firm, Alcolac, pleaded guilty to violating U.S. export controls by shipping 400 drums to Iran via Singapore and Pakistan (Warmkessel, 1989).

Table A.1

SCHEDULE A CHEMICALS AND ROLLING TEXT COUNTERPART[a]

U.S. Draft Treaty	Rolling Text[b]
Ethyl S-2-diisopropylaminoethyl methylphosphonothioate (VX)	0-alkyl alkylphosphonofluoridates e.g., Sarin Soman
Ethyl N, N-dimethylphosphoramidocyanidate (Tabun)	
Iso-propyl methylphosphonofluoridate (Sarin)	0-alkyl N,N-dialkylphosphoramidocyanidates e.g., Tabun
1,2,2-trimethylpropyl methylphosphonofluoridate (Soman)	0-alkyl S-2-dialkylaminoethylalkylphosphonothiolates e.g., VX
Bis (2-chloroethyl) sulfide (Mustard gas)	Sulfur mustards e.g., Mustard gas Sesquimustard 0-mustard
3-quinuclidinyl benzilate (BZ)	
Saxitoxin	
3,3-dimethylbutanol-2 (pinacolyl alcohol)	Lewisites Lewisite 1 Lewisite 2 Lewisite 3
Methylphosphonyl difluoride	Nitrogen mustards HN1 HN2 HN3
	3-quinuclidinyl benzilate (BZ)
	Alkylphosphonyldifluorides e.g., DF
	Ethyl 0-2-diisopropylaminoethyl alkylphosphonites e.g., QL
	Plus others to be discussed further.

SOURCES: U.S. Draft Treaty (CD/500); Rolling Text (CD/874).
[a]Called Schedule 1 in CD/874.

Table A.2

SCHEDULE B CHEMICALS AND ROLLING TEXT COUNTERPART[a]

U.S. Draft Treaty	Rolling Text
Carbonyl chloride (phosgene)	Phosgene
Cyanogen chloride	Cyanogen chloride
Hydrogen cyanide	Hydrogen cyanide
Phosphorus oxychloride	Phosphorus oxychloride
Phosphorus trichloride	Phosphorus trichloride
Trichloronitromethane (chloropicrin)	Trichloronitromethane (chloropicrin)
Thiodiglycol	Bracketed in Schedule 2
	Di- and trimethyl/ethyl esters of phosphorus P(III) acid
	Trimethyl phosphite
	Triethyl phosphite
	Dimethyl phosphite
	Diethyl phosphite
	Sulfur monochloride
	Sulfur dichloride

SOURCES: U.S. Draft Treaty (CD/500); Rolling Text (CD/874).

[a]Called Schedule 3 in CD/874.

An important feature of the draft treaty in a few cases and the Rolling Text in a number of cases is that some of the chemicals are listed generically. As we shall see in App. B, this lack of specificity presents a problem for identifying producers or users of the chemicals. It is the U.S. position that Saxitoxin, a substance also covered by the Biological Weapons Convention, and other toxins should fall under the CWC. This has not yet been adopted by the working group that prepares the Rolling Text. We note that the Rolling Text includes CAS numbers for each of the specific chemicals listed.

Table A.3

SCHEDULE C CHEMICALS AND ROLLING TEXT COUNTERPART[a]

U.S. Draft Treaty	Rolling Text[b]
Chemicals containing the P-methyl, P-ethyl, or P-propyl bond	Chemicals containing one P-methyl, P-ethyl, or P-propyl (normal or iso) bond
Methyl and/or ethyl esters of phosphorous acid	—
3,3-dimethyl butanol-2 (pinacolyl alcohol)	—
N,N-disubstituted-β-amino ethanols	N,N-diisopropylaminoethane-2-ol
N,N-disubstituted-β-amino ethane thiols	N,N-diisopropylaminoethane-2-thiol
N,N-disubstituted-β-aminoethyl ethyl halides	N,N-diisopropylaminoethyl-2-chloride
Phenyl-, alkyl- or cycloalkyl-substituted glycolic acids	2,2-diphenyl-2-hydroxyacetic acid and its esters
3- or 4-hydroxypiperidine and their derivatives	Quinuclidin-3-ol
	Arsenic trichloride
	N,N-dialkylphosphoramidic dihalides
	Di[illegible] N,N-dialkylphosphoramidates
	Plus others to be discussed further (including Thiodiglycol).

SOURCES: U.S. Draft Treaty (CD/500); Rolling Text (CD/874).

[a] Called Schedule 2 in CD/874.

Appendix B

PRODUCERS OF CW TREATY CHEMICALS

Appendix A described the routine inspection and reporti~g requirements for the three groups of treaty chemicals. Schedule A and C chemicals are to be subject both to routine inspection and to routine reporting. Schedule B chemicals are to be subject to routine reporting. In this appendix, we examine the reporting requirements that affect all three groups. In particular, in each case, under both the U.S. draft treaty and the Rolling Text, the location of all production facilities is required.

As discussed in the main text, the United States has two options for implementing the treaty requirements. The first is to establish a new entity to collect data specifically related to treaty requirements. The second is to use existing regulatory statutes and other publicly available data to satisfy the treaty requirements. The main text draws upon the available data given here in considering the second option, an exercise that illustrates the difficulty of relying solely on information from existing sources. Although, in principle, it might be possible to use only existing sources, in practice, there are significant barriers.

IDENTITY OF PRODUCERS

Table B.1 lists the Schedule C chemical producers as identified in various sources. For certain chemicals in the U.S. draft treaty or the Rolling Text, no producers were identified and they are not included in the table. Table B.2 specifies the producers—again from a variety of sources—of the generic chemical class in Schedule C—"chemicals containing the P-methyl, P-ethyl, or P-propyl bond." This table also includes several chemicals with other types of P-carbon bonds for completeness. Table B.3 lists the producers of Schedule B chemicals as given by the sources. We exclude producers of Schedule A chemicals because the agents have not been produced in the United States for nearly two decades.

The notable feature of Tables B.1 through B.3 is that the sources do not agree well on the identity of producers. Certain of the producers are known as "custom houses" and buyer's guides list them not necessarily because they produce the indicated chemical, but because they

Table B.1

SCHEDULE C CHEMICALS: PRODUCERS

Chemical	Producer/Supplier	Source[a]
Arsenic trichloride	Alfa Product, Morton Thiokol, Inc.	CW
	Atomergic Chemicals Corp.	CW
	Cerac, Inc.	CW, ACS
	Great Western Inorganics, Inc.	CW, OPD, ACS
	Metalspecialties, Inc.	CW
	Noah Chemical Division, Noah Industrial Corp.	CW
	Sharpe Chemicals Co.	CW, OPD
	United Mineral & Chemical Corp.	CW, OPD
3,3-Dimethyl-2-butanol	Chemical Dynamics Corp.	OPD
3-Quinuclidinol	Aldrich Chemical Co.	OPD
4-Hydroxypiperidine	Chemical Dynamics Corp.	OPD

[a]Designations are as follows: CW—*Chemical Week Buyer's Guide*; ACS—*American Chemical Society Chemcyclopedia*; OPD—*Chemical Marketing Reporter Buyer's Guide*; ITC—*International Trade Commission Report, Synthetic Organic Chemicals*.

could produce or supply the chemical if a buyer were interested. In addition, some firms may act as suppliers without actually producing the chemicals they market.

Another notable feature—of Table B.2 in particular—is that generic identification of chemicals makes it difficult to associate a complete list of chemicals with their producers. A chemist familiar with the structures must, by trial and error,[1] find the chemicals in the producer sources.

IMPLICATIONS FOR CW TREATY

The chemicals in Tables B.2 and B.3 are subject to routine reporting requirements under both the U.S. draft treaty and the Rolling Text; the chemicals in Table B.2 are subject to routine inspection. The fact that the different sources do not agree even on producer identity

[1]The ITC lists chemicals by end use, whereas the buyer's guides generally list them by chemical family in alphabetical order.

Table B.2

SCHEDULE C CHEMICALS WITH C-P BOND: PRODUCERS

Chemical	Producer/Supplier	Source[a]
P-methyl bond		
Dimethyl methylphosphonate	Albright & Wilson	CW, OPD, ACS, ITC
	Alfa Products, Morton Thiokol, Inc.	CW
Methylphosphonothioic dichloride	American Hoechst Corp.	OPD
	Ethyl Corp.	OPD, ACS
Methylphosphonic dichloride	American Hoechst Corp.	OPD
	Ethyl Corp.	OPD, ACS
Methylphosphonous dichloride	Ethyl Corp.	OPD
	Strem Chemicals, Inc.	ACS
Methylphosphonic acid	Alfa Products	OPD
P-ethyl bond		
Ethylphosphonothioic dichloride	Ethyl Corp.	OPD, ACS
0-ethyl-S-phenylethyl-phosphonodithioate	Stauffer Chemical	ITC
2-(chloroethyl) phosphonic acid	Union Carbide	ITC
Bis (2-chloroethyl)-2-chloroethylphosphonate	Albright & Wilson	ITC
Other P-carbon bonds[b]		
N, N-bis (phosphonomethyl) glycine	Monsanto	ITC
N-(phosphonomethyl) glycine, isopropylamine salt	Monsanto	ITC
N-(phosphonomethyl) glycine, sodium sesqui salt	Monsanto	ITC
Ethyl carbamoylphosphonate, ammonium salt	E. I. DuPont de Nemours	ITC
3-(dimethoxyphosphinyloxy)-N, N-dimethyl-cis-crotonamide	Shell Oil Co.	ITC

[a]Designations are as follows: CW—*Chemical Week Buyer's Guide*; OPD—*Chemical Marketing Reporter Buyer's Guide*; ACS—*American Chemical Society Chemcyclopedia*; ITC—*International Trade Commission Reporter*.

[b]May not be included in treaty categories.

Table B.3

SCHEDULE B CHEMICALS: PRODUCERS

Chemical	Producer/Supplier	Source[a]
Phosphorus oxychloride	Albright & Wilson, Inc.	OPD, CW, ACS
	Aldrich Chemical Co., Inc.	OPD, CW
	American Hoechst Corp.	OPD
	J. T. Baker Chemical Co.	ACS
	Captree Chemical Co.	CW
	Cerac, Inc.	CW, ACS
	D&O Chemicals, Inc.	OPD, CW
	FMC Corp.	OPD, CW, ACS
	J. F. Henry Chemical Co., Inc.	OPD
	Monsanto Co.	OPD, CW, ACS
	Noah Chemical Division	CW
	J. C. Schumacher Co.	CW, ACS
	Solkatronic Chemicals, Inc.	CW
	Stauffer Chemical Co.	OPD
	Synthatron	ACS
	Transene Co., Inc.	CW
	Joseph Turner & Co.	OPD
Phosphorus trichloride	Albright & Wilson, Inc.	OPD, CW, ACS
	Aldrich Chemical Co., Inc.	CW
	Alfa Products, Morton Thiokol, Inc.	CW
	American Hoechst Corp.	OPD
	Atomergic Chemicals Corp.	CW
	Cerac, Inc.	ACS
	D&O Chemicals, Inc.	OPD, CW
	FMC Corporation	OPD, CW, ACS
	J. F. Henry Chemical Co., Inc.	OPD
	Metalspecialties, Inc.	CW, ACS
	Monsanto Chemical Co.	OPD, CW, ACS
	Noah Chemical Division	CW
	J. C. Schumacher Co.	CW, ACS
	Stauffer Chemical Co.	OPD, CW
	Transene Co., Inc.	CW
	Joseph Turner & Co.	OPD
Phosgene	Alphagaz, a division of Liquid Air Corp.	CW
	BASF Wyandotte	CMR
	Dow Chemical USA	CW, CMR
	E. I. DuPont de Nemours & Co.	ITC
	Essex	CMR
	General Electric	CMR
	Matheson Gas Products	OPD, ACS
	Mobay Chemical Co.	ITC, CMR

Table B.3—continued

Chemical	Producer/Supplier	Source[a]
	Olin Corp.	ITC, CMR
	Oraynex, Inc. (subsidiary of Essex)	OPD
	PPG Industries, Inc.	OPD, ACS, ITC, CMR
	Rubicon, Inc.	ITC, CMR
	Stauffer	CMR
	Union Carbide Corp.	OPD, CW, ACS, ITC
	Upjohn Co. and Polymer Chemical Division	ITC, CMR
	Van de Mark Chemical Co., Inc.	OPD, CW, ITC, CMR
Cyanogen chloride	Atomergic Chemicals Corp.	CW
	Solkatronic Chemicals, Inc.	CW
	Synthatron Corp.	ACS
Hydrogen cyanide	Ciba-Geigy	CMR
	Cyanamic	CMR
	Degussa Corp.	OPD, CW, CMR
	Dow	CMR
	E. I. DuPont de Nemours & Co.	OPD, CW, ACS, CMR
	Fumico	ACS
	Monsanto	CMR
	Rohm and Haas	CMR
	Sohio Chemical Co.	ACS
	Standard Oil Co.	CW
Chloropicrin	Great Lakes Chemical Corp.	OPD, CW
	ICC Industries	ACS
	LCP Chemicals & Plastics, Inc.	CW
	Niklor Chemical Co., Inc.	OPD, CW, ACS
	Reichhold Chemicals, Inc.	OPD
Diethyl phosphite	Filo Chemical, Inc.	OPD
	Stauffer Chemical Co.	OPD
Dimethyl phosphite	Filo Chemical, Inc.	OPD
Triethyl phosphite	Albright & Wilson	CW, OPD, ITC
	Alfa Products, Morton Thiokol, Inc.	CW
	Filo Chemical, Inc.	OPD
	Stauffer, Product Intermediates	CW
	Stauffer Chemical Co.	CW, OPD, ITC
Trimethyl phosphite	Albright & Wilson	CW, OPD, ITC
	Alfa Products, Morton Thiokol, Inc.	CW
	Filo Chemical, Inc.	OPD
	Interchem Corp.	OPD

Table B.3—continued

Chemical	Producer/Supplier	Source[a]
	Stauffer, Product Intermediates	CW
	Stauffer Chemical Co.	CW
Sulfur monochloride	Aldrich Chemical Co., Inc.	OPD
	Alfa Products, Morton Thiokol, Inc.	CW
	GFS Chemical	OPD
	Occidental Chemical Corp.	CW, OPD, ACS
	Stauffer Chemical Co.	CW, OPD
Thiodiglycol	Alcolac	CW, ACS
	Cardinal Chemical Co.	OPD
	Crucible Chemical Co., Inc.	CW
	Dow Chemical	ITC
	Phillips Chemical Co.[b]	OPD, ACS, ITC
	Witco Corp.; Argus Div.	CW
	Morton Thiokol	ACS
	M&T Chemicals, Inc.	ITC
	X[c]	ITC
Sulfur dichloride	Aldrich Chemical Co., Inc.	OPD
	Alfa Products, Morton Thiokol, Inc.	CW
	Occidental Chemical Co.	CW, OPD, ACS
	Stauffer Chemical Co.	CW, OPD

[a]Designations are as follows: CMR—*Chemical Marketing Reporter Profiles*; CW—*Chemical Week Buyer's Guide*; OPD—*Chemical Marketing Reporter Buyer's Guide*; ACS—*American Chemical Society Chemcyclopedia*; ITC—*International Trade Commission Report, Synthetic Organic Chemicals*.

[b]Called Phillips 66 Co. in ACS and Phillips Petroleum Co. in OPD and ITC.

[c]X indicates unidentified producer for purposes of confidentiality.

suggests that implementation of treaty requirements using publicly available data will pose problems. There appears to be no way to identify all producers and to be sure that the list is all-inclusive. Since the United States is responsible for implementing the treaty requirements within its territory, the government must know the identity of all producers with certainty.

Without the help of the chemicals industry, the identity of producers of treaty chemicals cannot be determined accurately. Indeed, an organization like the Chemical Manufacturers Association (CMA) could

help in this effort. Many of their members are producers, and members producing a particular chemical are likely to know of other firms doing so.

The first step in approaching the question of whether the treaty implementation is possible with existing data is to identify the producers of the affected chemicals using publicly available information. Data on processors and others who are associated with these chemicals could also be required. This appendix illustrates the complexity of even this initial task. In App. C, we turn to the difficulties of satisfying other reporting requirements of the treaty.

Appendix C

CASE STUDIES OF ROUTINE REPORTING CHEMICALS

This appendix presents an analysis of the problems that arise in using existing information and regulatory statutes to satisfy the treaty requirements on reporting. We selected two chemicals listed in Schedule B as case studies—phosgene ($COCl_2$) and hydrogen cyanide (HCN). We chose them because they are commodity chemicals used on a wide scale in a variety of commercial processes and because, of all chemicals listed in the treaty, there are more publicly available data on them than on others.

In what follows, we present information on production and use for each chemical, then evaluate the quality of the data for satisfying treaty reporting requirements. Finally, we comment on the general inadequacy of existing sources.

PHOSGENE

Phosgene is a commodity chemical used primarily as an intermediate in the production of other chemicals. In 1984, demand was reported at 1.586 billion pounds (CMR, 12/3/84).

Production and Producers

Table C.1 shows the phosgene producers and their rated plant capacity for 1984 and for 1977 as given in one source. In 1984, there were 11 producers with 14 plants, whereas in 1977 there were 16 producers with 18 plants. Between 1977 and 1984, capacity increased by about 12 percent. These differences emphasize the changes that can occur in production practices over a short period of time.

The producers in Table C.1 are from the *Chemical Marketing Reporter*, a trade journal. In comparing the producers with the producers listed in Table B.3, we observe that the other publicly available sources list Alphagaz, Matheson Gas Products, Orsynex, Inc., and Union Carbide[1] in addition to those given in Table C.1. We might

[1] The footnote to Table C.1 indicates that DuPont produces phosgene, in agreement with Table B.3.

Table C.1

PHOSGENE PRODUCERS AND CAPACITY:
CHEMICAL MARKETING REPORTER

1984	
Producer[a]	Capacity (Millions of Pounds Annually)
BASF Wyandotte (Geismar, LA)	305
Dow (Freeport, TX)	145
Essex (Baltimore, MD)	10
General Electric (Mount Vernon, IN)	126
Mobay (New Martinsville, WV)	248
Mobay (Baytown, TX)	400
Olin (Lake Charles, LA)	160
PPG (Barberton, OH)	5
PPG (La Porte, TX)	67
Rubicon (Geismar, LA)	150
Stauffer (Cold Creek, AL)	60
Stauffer (St. Gabriel, LA)	30
Upjohn (La Porte, TX)	260
Van De Mark (Lockport, NY)	8
Total	1,974

1977	
Producer	Capacity[b] (Millions of Pounds Annually)
Allied (Moundsville, WV)	98
BASF Wyandotte (Geismar, LA)	55
Chemetron (La Porte, TX)	67
Dow (Freeport, TX)	130
DuPont (Deepwater, NJ)	135
General Electric (Mount Vernon, IN)	60
Jefferson (Port Neches, TX)	30
Minerec (Baltimore, MD)	8
Mobay (New Martinsville, WV)	250
Mobay (Baytown, TX)	250
Olin (Ashtabula, OH)	50
Olin (Lake Charles, LA)	120
PPG (Barberton, OH)	5
Stauffer (Cold Creek, AL)	25
Story (Muskegon, MI)	10
Union Carbide (Institute, WV)	140
Upjohn (La Porte, TX)	200
Van De Mark (Lockport, NY)	8
Total	1,766

SOURCES: *Chemical Marketing Reporter*, 12/3/84, 2/28/77.

[a]*Chemical Marketing Reporter* (12/3/84) indicates that Olin has an idle facility at Moundsville, West Virginia, and that DuPont produces phosgene at Deepwater, New Jersey.

[b]Includes phosgene produced and consumed in integrated isocyanate plants.

expect that the additional producers from Table B.3 are not simply "custom houses, producers who only produce the chemical for a special order"; this is not the case, however, since one of the producers, Union Carbide, is a very large multinational firm.

There are two regulatory statutes that allow EPA to collect information on chemical producers. As discussed in Sec. IV, under TSCA, producers of all chemicals in commerce[2] were identified as of 1977. A range of production for each producer was indicated if the producer did not claim confidentiality. Table C.2 shows the producers and the associated production ranges in the TSCA database.

Table C.2

PHOSGENE PRODUCERS AND PRODUCTION LEVEL: TSCA

Producer[a]	1977 Production Level (lb)
Allied Chemical (Moundsville, WV)	Not listed
BASF Wyandotte (Geismar, LA)	50 to 100 million
Chemetron Corp. (La Porte, TX)	10 to 50 million
Dow Chemical (Freeport, TX)	50 to 100 million
DuPont (Deepwater, NJ)	10 to 50 million
General Electric (Mount Vernon, IN)	50 to 100 million
Mobay (New Martinsville, WV)	100,000 to 1 million
Mobay (Baytown, TX)	10 to 50 million
Olin (Lake Charles, LA)	100 to 500 million
Olin (Ashtabula, OH)	10 to 50 million
PPG (Barberton, OH)	10 to 50 million
Rubicon (Geismar, LA)	Not listed
Stauffer (Bucks, AL)	10 to 50 million
Stauffer (St. Gabriel, LA)	10 to 50 million
Story (North Muskegon, MI)	10,000 to 100,000
Union Carbide (Institute, WV)	100 to 500 million
Upjohn (La Porte, TX)	Not listed
Van De Mark (Lockport, NY)	1 to 10 million

SOURCE: TSCA inventory database

[a]One producer is listed as confidential.

[2]Exceptions include radioactive substances and pesticides.

There are certain differences between Tables C.1 where the *Chemical Marketing Reporter* producers are listed and C.2 where the TSCA inventory producers are listed. First, Table C.2 shows Allied, Chemetron, Olin (Ashtabula, OH), Stauffer (Bucks, AL), Story, and Union Carbide and the 1984 column of Table C.1 does not. Second, the 1977 data of Table C.2 do show Allied, Chemetron, Olin, and Union Carbide. Table C.1 for 1984 lists Essex, PPG (La Porte, TX), and Stauffer (Cold Creek, LA) and Table C.1 does not. Third, the production ranges of Table C.2 show a 1977 production level which may not be currently valid.

The available TSCA data reflect 1977 producers and production levels. Although the TSCA database on producers may be updated in the future, the 1977 data are probably not useful for satisfying the treaty requirements. The data from producers have been recently collected by EPA and will be added to the database in the near future. According to one EPA source, many more plants are claiming confidentiality than in 1977. Thus, the data, although they will be more current, may be missing a number of entries.

According to a source in the Office of Pesticides and Toxic Substances at EPA, phosgene is not itself used as a pesticide but is used as an intermediate in the production of some 15 commercially important insecticides. As such, it is not listed in the FIFRA database.

Production data on phosgene are given in the TSCA database only in ranges and even these ranges are incomplete. The International Trade Commission reports annual aggregate production levels, and for 1985 lists phosgene production as 514 million pounds. As mentioned earlier, demand for phosgene was estimated at 1.6 billion pounds in 1984 by the *Chemical Marketing Reporter*. The discrepancy between the ITC and CMR levels may arise from the fact that the ITC reports only phosgene produced and isolated, whereas the CMR reports total demand. Thus, production in plants producing both phosgene and phosgene products would not be included in the ITC figures.

Use Data

Table C.3 shows the end uses of phosgene according to the *Chemical Marketing Reporter*. Most phosgene use—the first three categories plus "other isocyanates," and "agricultural uses"—represent intermediate use. Thus, nearly all the phosgene produced each year is converted to other chemicals.

Table C.4 lists the producers for 1984 of methylene bisphenylisocyanate (MDI) and toluene di-isocyanate (TDI), the major end uses of phosgene. In comparing Table C.2, which lists the phosgene producers,

Table C.3

END USES OF PHOSGENE: 1984

Use	Percentage of Phosgene[a]
Toluene di-isocyanate (TDI)	52
MDI and polymeric isocyanates	35
Polycarbonate resin	6
Other isocyanates, specialties, agricultural and miscellaneous uses	6

SOURCE: *Chemical Marketing Reporter*, 12/3/84.
[a]Does not total to 100 percent.

Table C.4

TDI AND MDI PRODUCERS: 1984

Producer	Chemical Produced
BASF Wyandotte (Geismar, LA)	TDI, MDI
Dow (Freeport, TX)	TDI
Mobay (Baytown, TX)	TDI, MDI
Mobay (New Martinsville, WV)	TDI, MDI
Olin (Lake Charles, LA)	TDI
Rubicon (Geismar, LA)	TDI, MDI
Upjohn (La Porte, TX)	MDI

SOURCES: *Chemical Marketing Reporter*, 11/19/84, 11/26/84.

and Table C.4, which lists the TDI and MDI producers, we note tha all the TDI and MDI producers also produce phosgene but not al phosgene producers produce TDI and MDI. We do not know whethe the phosgene intermediate in these plants is isolated.

The applications of phosgene other than TDI or MDI are not well defined. For instance, "other isocyanates," "specialties," "agriculture," and "miscellaneous" uses, involve a number of products and a numbe of chemicals. Without knowing the specific identities of the chemicals producers could not be identified.

Exports and Imports

The Bureau of Census collects data on imports and exports of chemicals. Phosgene apparently falls into a "basket" category because it is not listed separately. Such basket categories give import or export levels for a group of chemicals which are so classified because the trade value is below a certain threshold or because there is only one producer. The Bureau of Census employee we contacted was unable to identify which basket category phosgene fell into and said that it would cost $475 to conduct a preliminary investigation to see if the phosgene data could be released. If the data could be released, the Bureau would evaluate exports and imports of all chemicals in the category, an effort costing as much as $100,000.

HYDROGEN CYANIDE (HCN)

Hydrogen cyanide, like phosgene, is a commodity chemical used principally as an intermediate in the manufacture of other chemicals. In 1984, demand was estimated at 976 million pounds (CMR, 6/4/84).

Production and Producers

Table C.5 shows the hydrogen cyanide producers and their rated plant capacity for 1984 and for 1976 as given by the *Chemical Marketing Reporter*. Some of the HCN is produced as a byproduct in the manufacture of acrylonitrile, another commodity chemical, rather than as a primary product. Byproduct plants in Table C.4 are identified with a "B"; primary producers are identified with a "P."

To determine whether the producers of byproduct hydrogen cyanide are the same as the acrylonitrile producers, we compared a *Chemical Marketing Reporter* profile on acrylonitrile with the HCN producers in Table C.5. Two acrylonitrile plants—Sohio in Green Lake, Texas and Lima, Ohio—were specified and the two Vistron plants were not listed. The two Vistron producers in Green Lake and Lima probably correspond to the two Vistron plants.

Table C.5 indicates that in 1984 there were eight HCN producers with 14 plants. Total capacity amounted to 1.3 billion pounds. In 1976, six producers had eight plants. As footnote c in the table states, there were actually three additional DuPont plants that generated HCN as a byproduct in the production of adiponitrile. If these were included, the total number of plants would be 11. Total capacity in 1976 was about 0.6 billion pounds, less than half that of 1984.

Table C.5

HYDROGEN CYANIDE PRODUCERS AND CAPACITY:
CHEMICAL MARKETING REPORTER

1984	
Producer[a]	Capacity (10^6 lb)
Ciba-Geigy (St. Gabriel, LA) (P[b])	90
Ciba-Geigy (Glen Falls, WY) (P)	2
Cyanimid (Fortier, LA) (B)	35
Degussa (Mobile, AL) (P)	53
Dow (Freeport, TX) (P)	20
DuPont (Beaumont, TX) (B)	70
DuPont (Memphis, TN) (P)	145
DuPont (Orange, TX) (P)	285
DuPont (Victoria, TX) (P)	240
Monsanto (Chocolate Bayou, TX) (B)	50
Monsanto (Texas City, TX) (B)	50
Rohm and Haas (Deer Park, TX) (P)	200
Vistron (Green Lake, TX) (B)	40
Vistron (Lima, OH) (B)	36
Total	1,316

1976	
Producer[c]	Capacity (10^6 lb)
American Cyanamid (Fortier, LA) (B)	32
Dow (Freeport, TX) (P)	5
DuPont (Beaumont, TX) (B)	45
DuPont (Memphis, TN) (B,P)	185
Monsanto (Alvin, TX) (B)	66
Monsanto (Texas City, TX) (P)	75
Rohm and Haas (Houston, TX) (P)	160
Vistron (Lima, OH) (B)	40
Total	628

SOURCES: *Chemical Marketing Reporter*, 6/4/84, 11/15/76.

[a]Monsanto has about 65 million pounds of capacity on standby at Texas City, Texas. Shell Chemical owns the Mobile, Alabama plant operated by Degussa.

[b]P indicates primary; B indicates byproduct (see text).

[c]Excludes DePont's HCN capacity for adiponitrile at Victoria, Texas, Orange, Texas and La Place, Louisiana.

We can compare the producers in Table C.5 from the *Chemical Marketing Reporter* with those shown in Table B.3 in App. B. The other data sources list Furnico, Sohio Chemical Company, and Standard Oil Company in addition to those listed in Table C.4. Again, as was true for phosgene, these producers are not simply "custom" manufacturers but are large multinational firms.

In Table C.6, we show the producers given in the TSCA database, reflecting 1977 data. The TSCA 1977 inventory differs from the 1976 list of producers in Table C.5. The TSCA inventory identifies only one additional producer—Degussa—with no production in 1977. Although Table C.5 does not list the DuPont plants at La Place, Louisiana and Orange, Texas, they are mentioned in footnote c.

Hydrogen cyanide is also used as an insecticide in post-harvest fumigation for several crops. As such, it may be an active pesticide ingredient and producers should be listed in the FIFRA database. We have not pursued this.

The International Trade Commission does not provide a production level for hydrogen cyanide (U.S. ITC, 1985).

Table C.6

HYDROGEN CYANIDE PRODUCERS AND PRODUCTION LEVEL: TSCA

Producer	1977 Production Level (lb)
American Cyanamid (Westwego, LA)	Not listed
Degussa (Theodore, AL)	No 1977 production
Dow (Freeport, TX)	Not listed
DuPont (La Place, LA)	1 to 10 million
DuPont (Memphis, TN)	Not listed
DuPont (Beaumont, TX)	Not listed
DuPont (Orange, TX)	100 to 500 million
Monsanto (Texas City, TX)	10 to 50 million
Monsanto (Alvin, TX)	10 to 50 million
Rohm and Haas (Deer Park, TX)	Not listed
Vistron (Lima, OH)	10 to 50 million

SOURCE: TSCA inventory database.

Use Data

Table C.7 gives the end uses of hydrogen cyanide as given in the *Chemical Marketing Reporter.* As with phosgene, much of the hydrogen cyanide is used to produce other chemicals. Note that although the *Federal Register* shows HCN as an insecticide with specific tolerances on crops, the *Chemical Marketing Reporter* does not show any agricultural uses.

To our knowledge, the *Chemical Marketing Reporter* does not publish a chemical profile for adiponitrile, the chemical accounting for the major hydrogen cyanide use. The journal does publish such a profile for methyl methacrylate, which accounts for about one-third of the hydrogen cyanide use. The producers of this chemical are Cyro Industries in Fortier, Louisiana, DuPont in Memphis, Tennessee, and Rohm and Haas in Deer Park, Texas. In Tables C.5 and C.6, we observe that two of the methyl methacrylate producers manufacture HCN and one does not.

We have no information on the other uses of HCN.

Exports and Imports

According to sources at the Bureau of Commerce, hydrogen cyanide falls into a "basket" category called "Inorganic Acids, Not Otherwise Specified." Such basket categories aggregate export and import data for a number of different chemicals.

Table C.7

END USES OF HYDROGEN CYANIDE: 1984

Use	Percentage of Hydrogen Cyanide
Adiponitrile	38
Methyl methacrylate	35
Cyanide chloride	10
Chelating agents	7
Sodium cyanide	5
Nitrilotriacetic acid and salts	2
Methionine and other uses	3

SOURCE: *Chemical Marketing Reporter*, 6/4/84.

In terms of exports, the reference number for the HCN basket category is 416.5500 and the reference number for imports is 416.4540. Exports and imports in the category amounted to about 43.4 and 5.7 million pounds, respectively. As discussed for phosgene, there is no way of knowing how much to allocate to HCN.

Appendix D

INDUSTRY COOPERATION[1]

This appendix emphasizes the importance of industry participation in the early stages of legislation that will have a significant effect on current practices and procedures. Through a series of case studies, we argue that active involvement in the formulation phase will lead to a more favorable outcome from the industry's point of view.

In what follows, we briefly describe three case studies in which the industry had reasonable success in influencing final regulations through early participation. These include the vinyl chloride workplace emission standards, the Toxic Substances Control Act (TSCA), and the generic carcinogen policy.

We then present two examples where industry did not participate much in formulating the regulations. These include the chlorofluorocarbon (CFC) aerosol ban, and the November 8, 1986 land disposal restriction on untreated chlorinated solvents. In these cases, the industry had little opportunity to participate and was adversely affected.

Finally, we draw some parallels of the case studies and industry involvement in formulating inspection and reporting requirements in the CW treaty.

CASE STUDIES WITH INDUSTRY PARTICIPATION

We describe below three case studies in which industry supplied input from the beginning of the regulatory procedure and had substantial influence on the final rules. The first such case is the standard setting vinyl chloride levels in the workplace; the second case is the passage of the landmark TSCA; the third case is the attempt to introduce a generic approach to regulate carcinogens.

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[1]This material was briefed to CMA officials at a time when the chemical industry was far less engaged in treaty-related activities than at present. The intent was to demonstrate that both the nation's and industry's interests would be served by active involvement of U.S. firms.

Vinyl Chloride

Vinyl chloride (VC) was regulated in the 1970s on a number of important fronts. The chemical was scrutinized for workplace exposure, for general atmospheric exposure, in its use as an aerosol propellant, and in its use as packaging material. The one we examine here is the regulation of VC in the workplace by the Occupational Safety and Health Administration (OSHA).

On January 22, 1974, B. F. Goodrich, the largest vinyl chloride and polyvinyl chloride (PVC) manufacturer, announced that three of its workers had died of angiosarcoma in the previous two years. Angiosarcoma is a sufficiently rare liver cancer that there was little doubt the deaths were caused by exposure to VC. In April, OSHA set an emergency temporary standard for worker exposure in VC and PVC plants. It lowered the allowable exposure level from the 500 parts per million (ppm) historical standard to 50 ppm while the permanent standard was being prepared. On May 10, OSHA published its proposed standard which specified a "no detectable" level—in practice a standard of one ppm. In October, OSHA promulgated a final standard, to become effective 1 January 1975, of one ppm, the lowest level OSHA considered technically feasible.

Between May when the proposed standard was announced and October when the final standard was promulgated, industry actively participated in the regulatory process. In May, the Society of the Plastics Industry (SPI), a trade association, organized a series of meetings among representatives from 60 VC and PVC producers. These meetings culminated in a unified industry position that an exposure level of 25 ppm could be met by October of 1974 and a level of 10 ppm could be met by October of 1976.

By June, there were 19 reported worldwide deaths from angiosarcoma. One of these was a G. E. employee who had worked with PVC insulation; another was a woman who lived near a PVC plant. The cases suggested that the chemical could cause cancer in people who did not work in VC or PVC production plants. In April, just after the emergency temporary standard was set, OSHA received the results of a study that showed induction of liver angiosarcomas in rodents at the 50 ppm standard level. Later animal studies suggested that sarcoma and mammary tumors were caused at a one ppm exposure.

During the summer, OSHA received comments and held hearings on the proposed standard. The meetings were dominated by issues of technological and economic feasibility. The industry commissioned a study that estimated losses of between 1.7 and 2.2 million jobs and $65 to $90 billion in GNP for complying with the standard (Doniger, 1978).

An OSHA study, using industry estimates for one firm and extrapolating to the entire industry, suggested that compliance costs could amount to $900 million. One source places the actual compliance costs at $200 to $280 million. Three firms shut down plants but there is some indication that they were old and inefficient and would have been closed soon thereafter anyway; 375 jobs were lost.

Although the final VC standard was numerically equivalent to the proposed standard, the final standard was actually more lenient. In the proposed standard, VC concentrations were limited to a one ppm ceiling. The final standard set the concentration at one ppm averaged over an eight-hour workday. It also allowed excursions of up to five ppm averaged over any 15 minute period. OSHA also exempted PVC fabrication plants from monitoring and record keeping if they could show that VC levels were less than 500 ppb—half the allowable level. In the hearings, industry had lobbied heavily to increase the proposed standard and to exempt fabrication plants. In spite of testimony by the National Institute of Occupational Safety and Health (NIOSH) and National Cancer Institute (NCI), in which experts testified that no threshold level of VC safe for human exposure had been established, the industry activity had paid off. Although in the final standard, the threshold limit value was set lower than industry would have liked, some representatives of VC and PVC firms testified that a one ppm standard could be achieved easily.

By April of 1976, the industry had generally complied with the final standards. In Table D.1, we show production figures for VC and PVC for the period 1970 through 1976. The values show that production of both substances declined by some 30 percent between 1974 and 1975. Although much of the decline may be attributable to the stricter standard, some authors have argued that the recession and world oil crisis had more influence. In any case, production levels of the two chemicals generally recovered by 1976.

The Toxic Substances Control Act (TSCA)

TSCA was debated for five years before it was enacted by Congress in 1976. In 1975, the chemical industry accepted that such an act would be passed and acted to favorably influence its final form. At that time, the Chemical Manufacturers Association, then known as the Manufacturing Chemists Association, formed a committee to work directly with Congress and to make decisions on its own without consulting its member firms. Its aim was to ensure that the final form of TSCA was as reasonable as possible.

Table D.1

HISTORICAL VC AND PVC PRODUCTION
(Millions of pounds)

Year	VC	PVC
1970	4040	3115
1971	4336	3437
1972	5089	4322
1973	5351	4594
1974	5621	4744
1975	4196	3695
1976	5677	4545

Industry participation was extensive. The committee had a series of breakfast meetings with state and congressional delegations. The industry proposed 20 amendments to the House bill and met almost daily with congressional staff (*Chemical Week*, 4/27/77). The National Association of Manufacturers organized a group of small businesses that visited congressional offices.

In this case, too, the industry commissioned a study on the economic impact of the proposed legislation. It projected compliance costs at between $300 million and $1.3 billion and indicated that the number of new products would decline significantly (Brickman et al., 1985).

The bill as finally adopted addressed both new and existing chemicals, and in its final form, TSCA contained a number of concessions to the chemical industry. First, EPA must seek a court injunction to ban an existing chemical. Second, the definition of a new chemical exempted small volume chemicals used in research and development from toxicity testing. Third, the definition also exempted mixtures from testing when the components were known to be safe. Fourth, the bill limited the list of potentially hazardous existing chemicals to 50 rather than 300 as originally proposed. Fifth, in new chemical premanufacture notices (PMNs), the information requirements satisfied industry record keeping and confidentiality requirements (Brickman et al., 1985; *Business Week*, 10/25/76).

Even after the law was passed, the industry argued against EPA's draft on the information needs for the inventory of existing chemicals.

When the final rule was issued, EPA made concessions by devising methods for minimizing the requirements on small firms and protecting confidentiality.

The OSHA Carcinogen Policy

In the late 1970s, OSHA began developing a generic policy for regulating carcinogens in the workplace. In response, the industry promptly formed the American Industrial Health Council (AIHC) whose purpose was to formulate industry scientific views. The Council recommended establishment of a panel to identify and assess the risks of each substance. This would separate the science from the regulatory process. The AIHC also maintained that a generic approach would prevent testing flexibility and would mask complex scientific questions. The Council stressed that limited societal resources could best be allocated if both costs and benefits were taken into account. Once again, the industry commissioned a study that estimated capital costs for regulating more than 2000 chemicals at $88 billion—a number thought to be far too high by both sides in the debate (Brickman et al., 1985).

In this case, the industry succeeded in persuading OSHA to throw out the generic approach and to adopt instead a priority relative risk method. They also persuaded OSHA to examine regulatory strategies other than engineering controls, which industry considered too expensive.

CASE STUDIES WITHOUT INDUSTRY PARTICIPATION

Below, we describe two cases—one where industry did not participate early enough in the regulatory process, and another where industry did not lobby strongly enough against the statute. The first case involves the ban on chlorofluorocarbon use in aerosol propellants; the second case focuses on Congress' 1984 land disposal restrictions on solvents.

The Chlorofluorocarbon (CFC) Aerosol Ban

CFCs were first produced just after World War II. By 1970, six firms manufactured the chemicals which had found wide use as refrigerants, foam blowing agents, solvents, various miscellaneous products, and aerosol propellants.

In 1974, two scientists proposed a theory suggesting that fully halogenated CFCs were stable enough to reach the stratosphere (upper

atmosphere) intact. Once there, impinging radiation caused the molecules to decompose, liberating their chlorine. This chlorine, it was hypothesized, was then available to react catalytically with ozone shielding the earth from ultraviolet radiation (Molina and Roland, 1974). In September of that year, the *New York Times* published a front page article on the ozone depletion theory. In December of 1974, the first federal hearings were held on the extent of the hazard potential ozone depletion posed to the public welfare.

In February of 1975, the television series "All in the Family" implied that CFCs posed a danger to human health. In March, Oregon announced a ban on the sale of CFC aerosols that would become effective in March of 1977. In June, Johnson Wax ceased production of CFC-propelled products (Kavanaugh, 1984).

In November of 1976, the Food and Drug Administration (FDA) proposed a labeling requirement for CFC propelled aerosol products that are transported across state lines, accounting for about 80 percent of such products. By the end of that year, 30 states had held hearings on banning CFCs in aerosols.

In May of 1977, an interagency task force composed of the FDA, the Consumer Product Safety Commission (CPSC), and the EPA announced the CFC aerosol ban. By the end of that year, several major firms who marketed aerosol products—Gillette, Revlon, Alberto Culver, and Bristol-Myers—introduced non-aerosol or non-CFC aerosol products. In March of 1978, the final rules for the phaseout were promulgated. In December of that year, manufacturing of CFCs for propellant use was banned and in April of 1979, interstate shipments were halted.

Industry had little opportunity to counter the view that CFCs were bad for the environment. A 1979 National Academy of Sciences panel predicted that significant ozone depletion—approximately 16 percent—would occur if emissions of CFCs continued (NRC, 1979). The mood in the nation at the time was to ban CFCs in aerosols, and until about 1978 the industry did not organize to fight the action. By the time they did organize, there was talk of regulation of CFC non-aerosol use. Since then, the industry focus has been on the other CFC applications.

It is noted here that there is evidence that CFC propellants were losing their market share prior to the announced ban because they were more expensive to use than the alternatives. If, at that time, there actually was a movement away from CFCs, then the ban simply accelerated it. In that event, the industry would have been less inclined to organize to fight the regulation.

Land Disposal Restrictions on Chlorinated Solvents

In 1984, Congress passed the Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA). These amendments set forth a number of provisions requiring EPA to phase out the land disposal of virtually all untreated wastes by 1992 at the latest. The first set of substances to be addressed were solvents and dioxins.

In January 1986, EPA issued the proposed rules. Although there were several exemptions—for solvent dilute wastewater streams, for instance—virtually none affected the chlorinated solvents. The proposed regulation would prohibit land disposal of waster containing more than one percent or 10,000 ppm by weight of chlorinated solvents. In the event that the generator opted to treat the solvent waste, the legislation set strict treatment standards for the residues. By November 1988, the proposed regulations would exclude chlorinated solvents from land disposal altogether unless they met the stringent treatment standards (*Federal Register*, 1/14/86).

The industry response to the proposed regulations was minimal. Many people in the industry did not really understand the proposal and assumed that the exemptions applied to chlorinated solvents. Furthermore, the prevailing view in the industry was that the EPA would never promulgate final standards because they could not be met.

On November 7, EPA published the final rule that would go into effect on November 8, 1986. The final rule differed from the proposed rule in two respects. First, standards for treated waste were more stringent than proposed. Second, small quantity generators were exempted from the regulations for two years. Otherwise, the rule was promulgated as proposed (*Federal Register*, 11/7/86).

Various industry officials involved in the chlorinated solvents industry—equipment manufacturers, reclaimers, transporters, incinerator operators, and landfill operators—met with an EPA official in California approximately a week before the final rule went into effect. They were shocked that the rules would be promulgated and protested that incineration capacity for the waste solvents that were then disposed of on land was insufficient. The EPA official replied that the industry had had 10 months to supply EPA with data verifying the shortage of incineration capacity by quantifying increased user demand. He maintained that even after the final rule was issued, EPA would allow an exemption if the data were forthcoming.

The industry finally organized to deal with the land disposal restrictions. A committee was set up to gather data on user response and incineration capacity, and the Halogenated Solvents Industry Alliance

(HSIA) met with EPA to discuss the situation. In many respects, however, it was too late. Generators were already faced with meeting the new regulations, regulations that the industry felt would adversely affect many businesses. In this instance, the industry did not organize early in the rule-making; they had virtually no input into the process and the final regulation was not to their liking.

Appendix E

SAFEGUARDS IMPLEMENTATION IN THE UNITED STATES

The U.S.-IAEA agreement identifies material accounting, containment, and surveillance as principal safeguard measures. The United States is required to establish and maintain a system of accounting for and control of all civilian materials subject to safeguards. The International Atomic Energy Agency is to verify the results of U.S. accounting and control, and to notify the United States of its technical conclusions in terms of unaccounted material and the limits of accuracy.

The full U.S.-IAEA Safeguards treatment includes the designation of eligible nonmilitary facilities by the NRC; the selection of facilities for treatment by the IAEA; the gathering of data from the designated facility by the NRC pertaining to design, material accounting, and operating records; the submission of such data to the IAEA; a negotiated agreement between the NRC and the IAEA for a facility attachment[1] delineating the precise nature and location of safeguards and verification procedures for a specific facility, the facility operator acting as an advisor to NRC in this regard, and the on-site verification of safeguards by IAEA inspectors who may be accompanied by NRC representatives should the facility operator so desire. The results of the safeguard process are to be made available to the United States and the Director General of the IAEA. If the United States is required to bring the facility into compliance, the Board of the IAEA calls upon the United States to take the required action without delay. There is to be no public disclosure of data that could identify a specific facility.

FACILITIES ELIGIBILITY

The United States submits a list of eligible nuclear facilities (excluding facilities with direct national security significance) to the IAEA. This list is not static—it may change when new facilities go on-line and old ones are retired or otherwise change status. Furthermore, the United States may withdraw facilities at any time. The IAEA

[1] A facility attachment is the document delineating the necessary information for safeguards treatment.

identifies facilities for safeguards from the eligible list. The protocol to the U.S.-IAEA agreement stipulates that certain eligible facilities may be asked to submit inventory and design information but are not to be subject to the full safeguards treatment. These facilities may also be subject to limited inspections to verify design details. The United States is obliged to avoid discriminatory treatment of commercial firms on the eligible list, and the IAEA is expected to select facilities in accordance with this obligation. Facilities selected for safeguards are expected to remain in that status for at least two years, the minimum period for performing adequate verification. IAEA is obliged to provide its selection criteria if requested by the United States, and to meet with U.S. officials if the United States believes that the inspection selection is unfair. It was anticipated that two reactors and one fuel fabrication facility per two-year cycle would enter into the safeguards process, up to a maximum of fifteen. In addition to power, test, and research reactors, and fabrication and processing facilities, the Portsmouth centrifuge enrichment facility was being prepared for safeguards prior to its cancellation.

DESIGN INFORMATION

The United States provides design information for each facility selected by the IAEA, including descriptive information about the facility and its operations, the characteristics of nuclear material within the facility, and the nuclear material accounting and control procedures. Design data are to be provided the IAEA within 45 days after selection, and change in design information is to be noted at least 60 days before the change is completed.

The design information is to be used for planning the implementation of safeguards at the facility. The CFR (10 CFR, Ch1, pt75) specifies the information to be provided, including the determination of IAEA material balance areas; key measurement points to determine the flow and inventory of nuclear material; selection of containment and surveillance methods and the strategic points at which they are to be applied; and detailed security measures. In the mandate are specific procedures for nuclear material accounting and control, establishment of material balance areas, and physical inventory taking.

The NRC is obliged to balance the legitimate desires of operators to protect their competitive position against the need to facilitate the implementation of the safeguards agreement. For commercially sensitive process steps, the operator may establish a special material balance area to restrict IAEA access, and information deemed sensitive

(proprietary or trade secrets) may be treated in a special manner. The operator may request that information not be transmitted *physically* to the IAEA. If the request is denied, the operator must be notified within ten days (sufficient time for judicial review), at which time the material will be physically transmitted to the Agency. If a request is granted, the IAEA may examine the material without taking possession. In addition, the NRC may also determine, either alone or at the request of the operator, that other information need not be physically transmitted or made available for IAEA examination.

Proprietary design information would be exempt from inspection and copying by the public if it constitutes trade secrets or privileged or confidential commercial information. The material may be requested to be withheld from public disclosure under the Freedom of Information Act, and if such request is granted, would be exempt from discovery in judicial proceedings but not necessarily exempt from disclosure to Congress.

The NRC permits operators to be consulted in the negotiating of facility "attachments," documents that describe the detailed safeguards arrangement for a particular facility. The development of the facility attachment thus involves a formal negotiation between IAEA and the United States, with the facility operator acting as a consultant. The facility operator has a purely advisory role and does not participate directly in negotiations. If the operator's views are not given due consideration by the NRC, the operator is free to seek judicial review.

MATERIAL ACCOUNTING AND OPERATING RECORDS

Once notified by the NRC, the operator should establish, maintain, and follow written material accounting and control procedures: physical inventory procedures; measurement systems including measurement accuracy and uncertainties; and inventory changes, book inventories, and physical inventories relating to each material balance area. The aim of the material accounting approach is to define the material quantities that are received, produced, shipped, lost, or otherwise removed from inventory. Operating records are required for each material balance area to provide operating data and to establish changes in the quantity and composition of nuclear material. If losses or changes exceed the quantities developed in each facility attachment, the United States is to notify the Agency.

Since the United States already maintains an accounting and control system that duplicates the IAEA-required data, facilities that are selected for safeguards and that must comply with IAEA reporting

goals bear little additional reporting burden. Furthermore, the domestic safeguards reporting system has been modified to ensure that IAEA and corresponding U.S. information needs are satisfied by a single system of reports. Thus, the incremental cost of complying with IAEA safeguards reporting requirements is low since the same accounting data are already reported to the NRC. As noted earlier, eligible civilian facilities that are not selected for the full safeguards treatment are covered by the protocol to the U.S.-IAEA Agreement, which requires a series of reports similar to those described above but without the full on-site inspection process. In the United States, only power reactors and fuel rod fabrication plants are now under IAEA jurisdiction; in nonnuclear weapons states, reprocessing plants and isotope separation facilities would also be covered.

INSPECTION AND VERIFICATION

Once a facility is designated, it is subject to inspection by the IAEA to verify that design and other facility information is correct. At least three days' notice from the NRC is required, but the facility operator consults with NRC if the proposed date is not suitable. The operator will accompany IAEA staff (and NRC observers) during the visit, but is not to delay the exercise of IAEA activities.

As defined earlier, inspections are of three types: ad hoc, routine, and special. All inspections are classified as routine unless the NRC otherwise notifies the operator. Ad hoc inspections are intended to verify information contained in the initial reports to IAEA, including inventories and the quantity and composition of nuclear imports and exports. These inspections are to be carried out at locations designated in the initial reports, or in the case of imports and exports, places where such material may be located. Except for exports, where only 24 hours' notice is theoretically required, ad hoc inspections involve a notice of at least a week.

Routine inspections are carried out at designated *strategic* points which are the key measurement points for determining the flow and inventory of nuclear material, based on the concept of material balance. They are to verify the mutual consistency of reports and records and to determine the source of errors or discrepancies in material accounting. Special inspections can be performed at the same locations as the routine and ad hoc types, or at other locations that the NRC, in response to IAEA request, finds necessary.

Inspectors are permitted to examine material accounting and control records; observe that material balance accounting measurements are

representative; verify the functioning and calibration of instruments and controls; observe that samples, including duplicates, are selected suitably and monitor their treatment and analysis, and to use IAEA equipment for independent measurement and surveillance. The operator is expected to assist IAEA inspectors who may request that he ship samples; enable IAEA to install its measuring and surveillance equipment; enable IAEA to apply seals and tamper-indication devices to containers; make additional measurements, including more samples for IAEA use; analyze IAEA's standard analytical samples; and carry out needed calibrations.

ACCESS

The frequency and intensity of routine inspections are to be at the minimum consistent with the goals of adequate treaty implementation and are to be performed in a cost-effective way. The maximum total duration of such inspections is, for amounts over 5 kg, one-sixth of a man year for reactors and sealed storage installations. For facilities that involve plutonium or enriched uranium, the maximum yearly total of routine inspections is 30 × E man-days per year, where E is a measure of inventory or annual throughput in effective kg. The maximum shall not be less than 1.5 man-years of inspection. For other facilities, the maximum total is a linear function of E. The actual number, intensity, duration, and mode of routine inspections are functions of the types of material, containment, and effectiveness of the U.S. accounting and control system including past compliance record of U.S. facilities, and technical advances in safeguard technology including statistical techniques and random sampling. The agency is supposed to make full use of technology and to perform its activities with "optimum" cost-effectiveness. Although the agency statute asserts that inspectors shall have universal access at all times to all places, data, and persons, the agency has never tried to enforce this potentially intrusive policy. In both nuclear and nonnuclear weapons states, the IAEA has not even fulfilled the routine inspection obligations that correspond to the ARIE (Actual Routine Inspection Effort) quantity listed in facilities agreements. Typical U.S. inspections take 60 man-days/year over a two-year period.

Defining what is meant by appropriate access is difficult, particularly in plants that process weapon-usable material. Operators of foreign reprocessing plants have generally agreed to no more than two complete inventories a year. Since the characteristic times associated with the goal of timely detection in such plants are short, the IAEA

performs frequent but only partial inventories at them. In practice, the IAEA has not invoked special inspection procedures that might be applied to gain greater access. The concept of limited frequency unannounced access was recently developed for inspecting gas centrifuge technology, but was never invoked because the Portsmouth gas centrifuge plant was cancelled.

DESIGNATION AND ACCEPTANCE OF INSPECTORS

Almost every government has invoked its right of veto on individuals or classes of inspectors. Countries have recently made it clear that whole categories of inspectors are not acceptable. To a certain extent, this simplifies the Director General's task of selecting inspectors. It may also avoid potential friction between inspectors and host nations.

The Safeguards Agreement specifies a set of procedures pertaining to the designation of inspectors. The Agency submits the name, nationality, and other characteristics of the officials that it proposes for inspection of U.S. facilities. The United States informs IAEA's Director General within 30 days of the acceptance or nonacceptance of the nominees. There is no limit on the number of vetos, nor must the United States (or any other signatory to the NPT) explain its veto. Some common explanations (Fischer and Szasz, 1985) given by other nations are that persons will be accepted only if they are (1) nationals of countries that have accepted safeguards (since the Soviets only recently completed an agreement with IAEA, this effectively restricted on-site inspections by Soviet nationals); (2) inspectors who are *not* nationals of specified countries; (3) inspectors who speak the language of the inspected nation; (4) inspectors who are nationals of countries that have diplomatic relations with the inspected country; and (5) inspectors whose native countries already possess certain types of nuclear technology. (This has been invoked in the case of some enrichment plants as a means of limiting technology transfer.) Nearly 10 percent of inspection time is lost to refusals to accept inspectors (Scheinman, seminar at RAND, 1988).

The Director General is authorized to bring to the notice of the IAEA's Board of Governors a state engaging in repeated vetos. This is not invoked in practice because states often reveal their acceptance criteria in advance and the IAEA's preference is for a conciliatory rather than a confrontational mode of operation. To illustrate: the only Israeli inspector employed by IAEA has not been involved in any inspection tasks but rather is assigned to work in Vienna, under instructions from the Board of Governors.

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